2009

Barbed bone and antler technologies: cultural transmission and variation in the Gulf of Georgia, Northwest North America

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BARBED BONE AND ANTLER TECHNOLOGIES: CULTURAL TRANSMISSION AND VARIATION IN THE GULF OF GEORGIA, NORTHWEST NORTH AMERICA

By

Adam N. Rorabaugh

Accepted in Partial Completion of the

Requirements for the Degree

Master of Arts

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MASTER'S THESIS

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A Thesis
Presented to
The Faculty of
Western Washington University

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

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Adam N. Rorabaugh
February 2009

ERRATA

A radiocarbon date from 45WH17 Semiahmoo Spit was erroneously reported in the original hard copy version of the thesis as 4715±55 BP in Figure 6.2 and Table 6.6. The correct date of 2715±55 BP is now used in place. The incorrect radiocarbon date was not used for artifact age assignments, and does not effect any of the analyses.

ABSTRACT

Although archaeologists have long discussed the evolution of the social stratification and complex group interactions of the hunter-gatherer-fishers of the Northwest Coast (e.g. Matson and Coupland 1994; Ames 1994), few have examined the implied interactions between material culture and the development of complexity in the Gulf of Georgia postulated to have occurred approximately 2600 years ago. When viewed from a Darwinian perspective, specifically Boyd and Richerson's (1985) dual inheritance theory, the development of social stratification and systems of deference may influence the contexts of social learning. I hypothesize that prestige bias (Henrich and Henrich 2007) emerged as a factor in the social learning of technologies tied to systems of resource procurement and prestige-based status, as complexity developed. Barbed bone and antler points are examined in this analysis as a technology tied to these resource systems and prestige-based status.

A total of 593 artifacts were examined from 56 archaeological sites from the collections at Western Washington University, the Burke Museum, the Royal British Columbia Museum, and Simon Fraser University. McMurdo's (1972) typology was used as a basis for the examination of attributes. Cladistics was employed using models developed by Eerkens and his coauthors. (2006) in order to detect prestige bias, represented by a branching phylogeny of descent with modification as opposed to a stochastic pattern. Dunnell's (1978) definition of stylistic and functional traits coupled with cluster analyses were utilized in the examination of attributes to select traits that would not result in a 'false' phylogenetic signal due to artifact functional constraints.

In addition to examining the cultural transmission of barbed bone and antler points, the data set was also used to assess previous interpretations of artifact function (e.g. Carlson 1954). Four functional classes (retrievable points, fixed points, leisters, fish hooks) were constructed for this purpose and to determine if there were distinctions in metric attributes between classes. Variation within fixed points was also examined to determine if there were detectable distinctions in attributes hypothesized to be linked to functions such as a fish spears or arrow points (e.g. Carlson 1954, Clark 1975) such as barb morphology, cross-section, and base length. The cultural-historical significance of attributes such as the transition from bilateral to unilateral barb application and line attachments through time and the trend towards squared, enclosed, barbs in later periods were also assessed (Drucker 1943; McMurdo 1972).

Cladistics analysis, using geographically and chronologically outlying assemblages as an outgroup, revealed a stochastic pattern of cultural transmission, implying highly individualized (guided variation) or peer based learning (horizontal transmission) rather than prestige bias. Cluster analyses demonstrate considerable geographic homogeneity in the morphological attributes of barbed points, indicating that similar barbed point styles were present throughout the Gulf of Georgia over the past 3500 years. Barb morphological attributes, as indicated by the frequencies of barb paradigmatic classes, also demonstrate considerable continuity over the past 3500 years. Clear distinctions were detected in the metric attributes of morphologically defined functional classes. Variation in the morphology of fixed points, indicative of possible function as a fish spear or bird arrow was also detected. Attributes McMurdo (1972) argued had culture-historic significance, with the exception of those tied to barb morphology, were found to be chronologically sensitive.

ACKNOWLEDGMENTS

First and foremost I am grateful to the members of my committee, Dr. Sarah K. Campbell, Dr. Todd A. Koetje, and Dr. Joan C. Stevenson for their advice, guidance, and insight at each stage of this project. I also wish to thank the Western Washington University Graduate School for the research funding which was used to acquire radiocarbon dates. In no particular order I would like to thank Dr. Laura Phillips and Dr. Stephen Denton of the Burke Museum, Dr. Grant Keddie and Dr. Martina Steffen of the Royal British Columbia Museum, Dr. Barbara J. Winters and Dr. Roy A. Carlson of Simon Fraser University for access to their collections and their invaluable insights to the material culture of the Northwest Coast. I also wish to thank Washington State Parks for providing access to their collections at the Burke Museum for research purposes. For their feedback on the theoretical aspects of this thesis, I wish to thank Dr. Barry Hewlett of Washington State University: Vancouver, Dr. Jelmer Eerkens of University of California: Davis, and Dr. Felix Riede of Cambridge University. I also thank Dr. James C. Chatters for encouraging me to examine climactic models which may account for some of the changes seen in barbed bone and antler technologies in the region through time.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

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LIST OF FIGURES

LIST OF FIGURES (CONT.)

LIST OF FIGURES (CONT.)

LIST OF TABLES

LIST OF TABLES (CONT.)

I. INTRODUCTION

Barbed bone and antler points demonstrate considerable morphological variation through time in the archaeological record of the Gulf of Georgia region of northwestern North America. Previous investigators have devised typological classifications (e.g. Drucker 1943; Hoover 1971), discussed the cultural-historical significance of attributes (e.g. McMurdo 1972), and interpreted their functions based on ethnographic analogy (e.g. Carlson 1954). Thus, the morphological variation of barbed points is well documented, as is their role in the resource procurement systems of Coast Salish peoples. However, the variation in points cannot be accounted for by changes in artifact function alone (Mitchell 1990:345). Omitted from the examination of these points, which were used as fish hooks, leisters, fish spears, bird arrows, and harpoons, are behavioral interpretations about the social contexts which may have affected stylistic attributes of these technologies, as these peoples shifted from egalitarian society to a more hierarchical prestige system during the Locarno Beach period (3200-2600 BP). Large-scale salmon storage and residential base camps first emerged and maritime subsistence strategies intensified in this period (Matson and Coupland 1994; Borden 1950). By 2600 years ago, in the subsequent Marpole period, there is evidence of increased settlement size, sedentism, and social stratification.

Contextual evidence supporting increasing social stratification includes status markers such as labret wear on anterior teeth, cranial deformation, and inherited prestige goods in child burials (Cylbuksi 1993; Beattie 1981; Burley and Knusel 1989; Ames 2001). Another strategy for documenting this social transition at specific archaeological sites would be demonstrating the transmission of stylistic attributes of tools. Was influenced by the growing importance of prestige. Henrich and Henrich (2007) argue that the presence of elites influences culture transmission in that lower status individuals are more likely to imitate the successful, higher status individuals (prestige bias). Henrich and Henrich's model is based on Darwinian models of gene-culture co-evolution (dual inheritance) first presented by Robert Boyd and Peter Richerson (1985). Cultural information may be transferred from person to person in a variety of ways. Boyd and Richerson distinguish between direct and indirect bias. Direct bias occurs when a cultural trait is selected by individuals based on the qualities of the cultural variant. Indirect bias occurs when a cultural variant is selected based on factors unrelated to the cultural variant. Selection based on social status, or prestige bias, is a form of indirect bias. The goal here is to determine if the shifts in social organization that occur at the end of the Locarno Beach period in the Gulf of Georgia are reflected in aspects of material culture other than status items due to changes in how models are selected in the learning of technologies.

The changes in cultural transmission resulting from a shift from egalitarian to prestige-based status should be evident in material culture. Eerkens and his coauthors (2006) simulated different modes of cultural transmission and found two overall patterns. The first of these patterns is a 'non-conservative mode' that exhibits a stochastic pattern of descent with interconnecting branches. In a society in which individuals produce tools reflecting local preferences (personal style, peers, etc.), the non-conservative mode should be dominant. The second pattern is a 'conservative' mode, exhibiting a tree-like branching phylogeny. In a society where elite individuals are very influential and are imitated, morphological variation reduces as elites exert more social influence, and the conservative mode should be prevalent.

One limitation of the above approach is that functional constraints on artifacts may reduce morphological variation. This can be independent of the stylistic attributes influenced by social learning and result in a 'false' phylogenetic signal. In other words, severe functional constraints will lead to homogeneity through time resulting in the same branching pattern associated with the conservative cultural transmission model of Eerkens and coauthors. (2006). Dunnell (1978) provides a means of distinguishing between stylistic and functional attributes of artifacts. His approach is useful in selecting stylistic attributes that are not constrained by their function. The patterns in stylistic change over time for almost 600 barbed points representing 56 sites in the Gulf of Georgia (Figure 1.1) over the past 5500 years were used here to generate branching models to detect the influence of prestige bias, which I postulate accompanied the shift to a prestige-based social system.

Barbed points are defined along with their many uses in a variety of contexts worldwide in Chapter 2. Also discussed are systems of classification for barbed points from the Northwest Coast. The dual inheritance approach is outlined in Chapter 3 along with the application of phylogenetic methods to the analysis of material culture. The ethnohistoric context of Coast Salish barbed points and the archaeological evidence for the emergence of prestige-based status are discussed in Chapter 4. I also provide models of cultural transmission factors that may have influenced the social learning of barbed points in Coast Salish prehistory. Methods, Results, Discussion and Conclusions follow in Chapters 5, 6, 7, and 8.

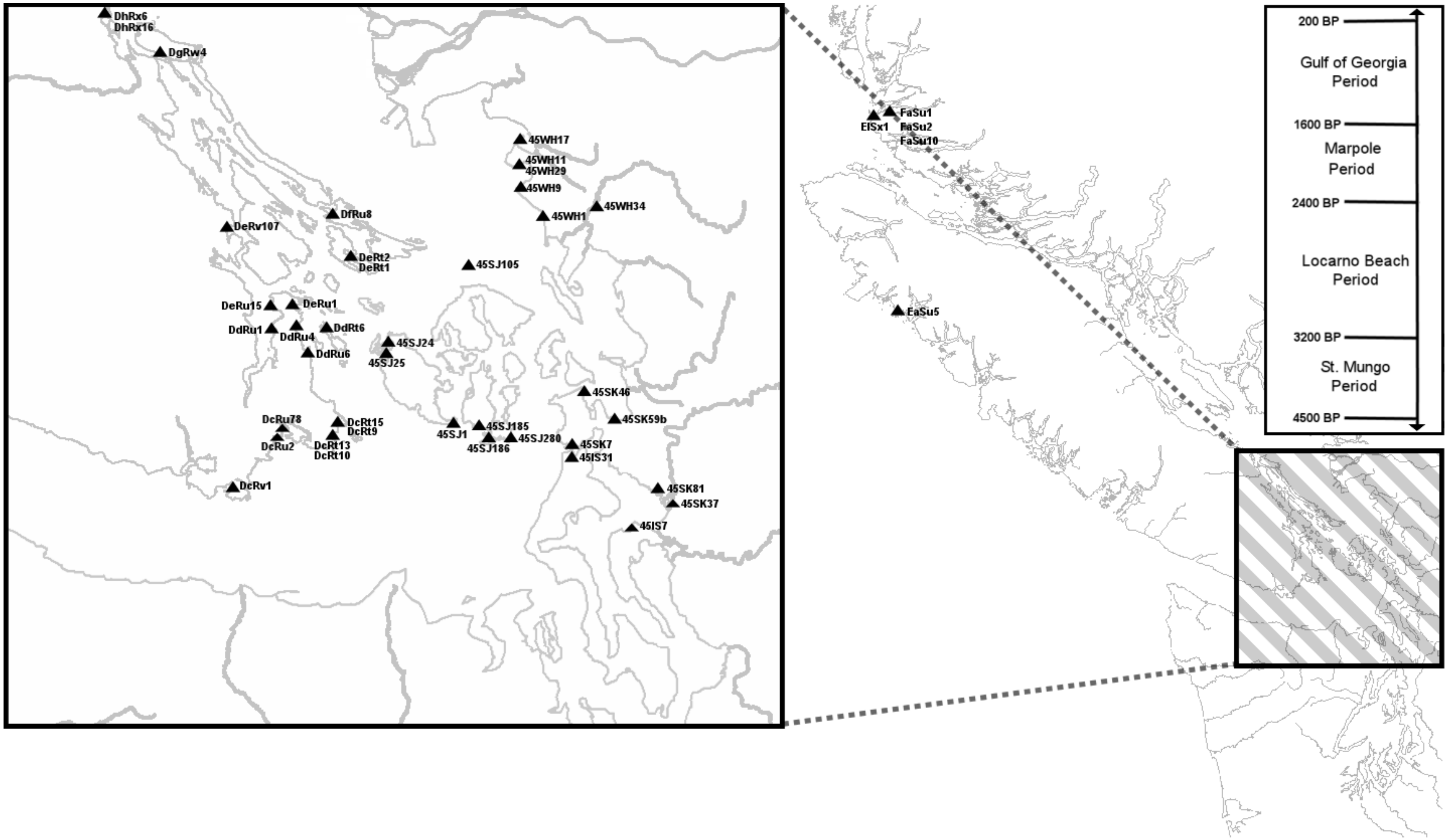


Figure 1.1. Sites With Barbed Points Included in this Analysis and Gulf of Georgia Regional Chronology (Borden phases from Mitchell 1990:340).

II. BARBED BONE AND ANTLER PROJECTILES OF THE NORTHWEST COAST, GENERAL CONTEXT AND HISTORY OF APPROACHES

Barbed bone and antler projectiles exhibit a high degree of variation in both form and inferred function. These technologies were used to acquire marine, riverine, and terrestrial resources. In this chapter, I define barbed bone points, discuss their global and regional context, and provide an overview of previous approaches to their study on the Northwest Coast. My examination of previous approaches is divided into two segments: the first pertains to typological approaches while the second deals with functional approaches based on ethnographic analog. This is followed by a discussion of these functional interpretations.

Definition

Barbed bone and antler points are defined as artifacts produced from bone or antler which have a hafting element, tapering thin edges which converge to a point on the distal end of the object, and one or more projections on their lateral surfaces. For barbed points that are inserted into a foreshaft, the hafting element is referred to as the 'tang' (Hoover 1974:6-7), and may have lateral projections, notches, or perforations for the attachment of a retrieving line.

Fish hooks, leisters, fish spears, bird arrows, and harpoons are traditional Coast Salish tool types which incorporate of barbed bone or antler points. Harpoon points can be either tanged or socketed. Only tanged harpoons have been included in this analysis, although socketed harpoons are discussed.

Barbed Point Types

'Harpoon' and 'fish spear' have often been loosely used to refer to a variety of bone and antler implements used to capture prey (e.g. Suttles 1951; Berringer 1982; Emmons et al. 1991). Barbed point types and the terminology used in their discussion are provided below, and are illustrated in Figure 2.1. Definitions for point functional types used throughout this thesis are provided in Table 2.1.

Table 2.1. Functional Class Definitions.

Class	Definition
Retrievable Point	Barbed bone and antler points with a line attachment can be bilateral or unilateral
Fixed Point	Barbed bone and antler points without a line attachment and with symmetrical bases, can be bilateral or unilateral
Leister/Multiple Fixed Point	Barbed bone and antler points without a line attachment and curved profiles or asymmetrical bases, unilateral
Fish Hook	Barbed unipoints, may have asymmetrical bases, unilateral

Harpoons (Retrievable Points)

Harpoons are defined as piercing projectiles with a detachable head that is retrievable due to the presence of a line attachment (Mason 1902; Rostlund 1952). There is considerable variation in the forms as well as function of harpoon technologies ranging from one piece projectiles to complex, multi-part harpoons. The distal end of a harpoon head, the portion that penetrates the prey, is referred to as the arming element

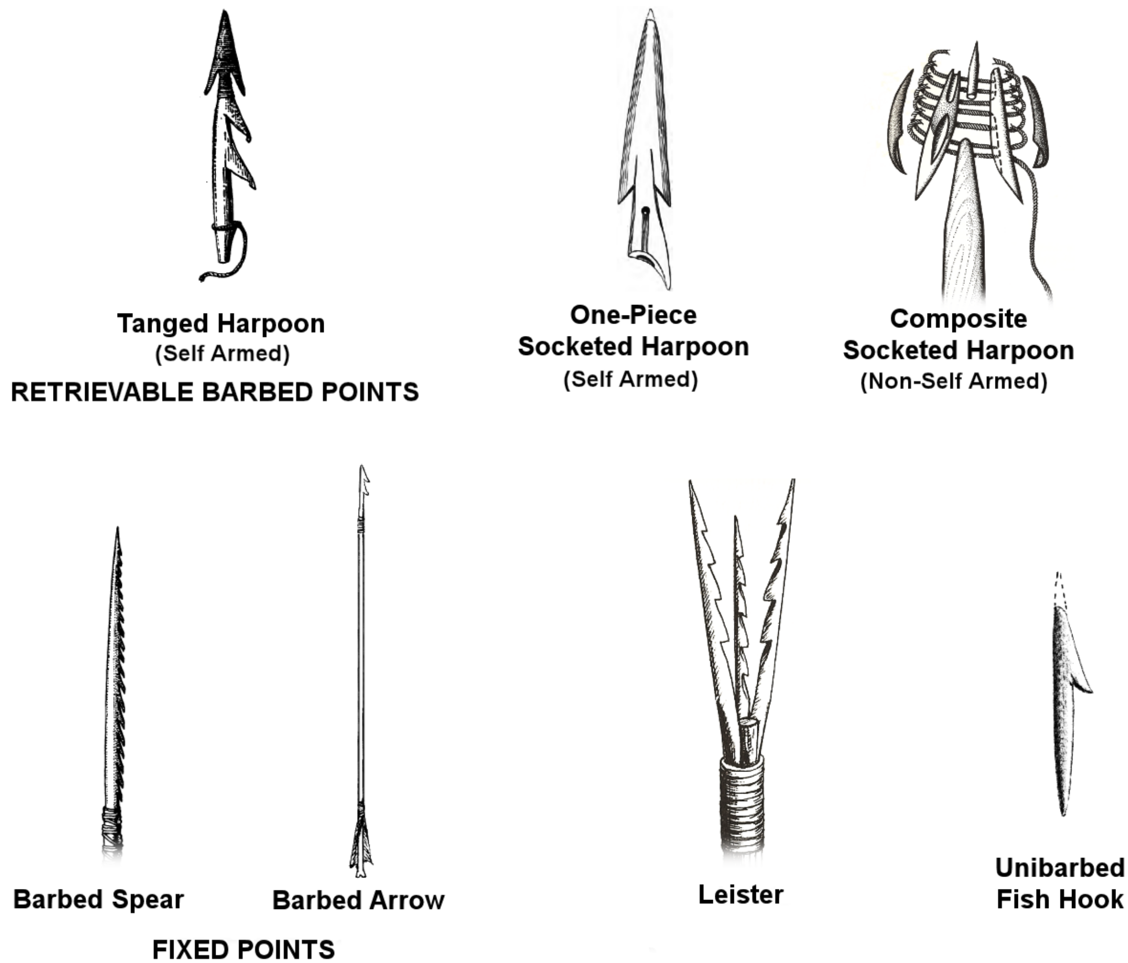


Figure 2.1. Examples of Barbed Point and Harpoon Types.
(Original Tanged Harpoon, One-Piece Socketed Harpoon, and Fish Spear line art from Mason 1902: Plate 2, 228; Original Composite Socketed Harpoon line art from Drucker 1965: 12; Original Barbed Arrow and Barbed Unipoint Fish Hook line art from Stewart 1973: 106; Original Leister line art from Stewart 1977: 67. Images are not to scale. One-Piece Socketed and Composite Harpoons are not examined.)

(Hoover 1974:7-8). Harpoon heads, such as the composite salmon harpoons of the historic period, or harpoons with a slot for a slate or shell blade, may have an arming element separate from the head and are considered not self-arming.

The proximal end of a harpoon can be either socketed or tanged (Hoover 1974). Socketed harpoons have a proximal concavity for the placement of a foreshaft or shaft tip and may be one-piece or composite (Hoover 1974:6-7). Tanged harpoons have a proximal projection which fits into a concavity on the distal end of a foreshaft. I use Hoover's distinction between socketed and tanged harpoons as it is more applicable than Drucker's (1943:36-37) distinction between one-piece and composite harpoons. This is because tanged harpoons are considered as more morphologically similar to other barbed bone points than to one-piece socketed harpoons.

The term 'toggling' has been used to describe socketed harpoons (e.g. McMurdo 1972). I avoid using this term as toggling is a specific functional interpretation which could be independent of a point being socketed or tanged. Toggling harpoons are defined as, "[harpoons] in which the head assumes a transverse position when an obstruction is encountered." (Jochelson 1925:53). The head of a toggling harpoon, which can be one-piece or composite, is driven in its entirety within the prey, where it 'toggles' under the skin for a secure hold. Only tanged, self-armed, harpoons are examined here, and I refer to them as retrievable points. Examples of unilaterally (Figure 2.2) and bilaterally (Figure 2.3) barbed retrievable points are provided.

Figure 2.2. Antler Retrievable Point with Combination Line Attachment. (DfRu8, Cat. #470 Photo Courtesy Simon Fraser University. Ventral and dorsal views provided.)

Figure 2.3. Antler Retrievable Point with Bilateral Barb Application and Line Attachment. (ElSx1, fs4.0.27 Photo Courtesy Simon Fraser University. Ventral and dorsal views provided.)

Barbed Spears and Barbed Arrows (Fixed Points)

Barbed arrows and spears are are bone points lacking line attachments (Figures 2.4). Many early studies of paleolithic European barbed points (e.g. Sarauw 1903) defined points lacking line attachments as harpoons. Although the definition of harpoon as a retrievable point has existed for over a century (Mason 1902), Stein (2000:100) notes that points lacking line attachments have been referred to as harpoons by Northwest Coast archaeologists. 'Harpoon' is used here to refer only to points with an obvious morphological method of line attachment.

Carlson (1954:24) distinguishes between barbed arrows and spears on the basis of their profile and base. Similarly, McMurdo's (1972:39, 68, 86, 88) typological approach, discussed later, includes types (Class II, Type I and II) which are interpreted as bird arrows. Similarly, the central interior prong of a leister would be considered a fixed point. While I do not distinguish between types of fixed points in my functional classes, fixed point functional variation is examined in Chapter 6.

Figure 2.4. Antler Fixed Point, Missing Head. (45SJ24 , SAJH137080, Photo Courtesy Burke Museum. Ventral and dorsal views provided.)

Leisters

Leisters are defined as multi pronged spears used for fishing (Suttles 1951:143). The outer prongs of a leister are recurved inward towards a central, interior, prong (Berringer 1982:40-42). Barbed leister points are side hafted to a shaft, and generally have curved profiles (Figure 2.5). I define leister side prongs as tanged barbed points with curved profiles or asymmetrical bases and more than one barb. I argue that only the side hafted points of a leister can have their function positively identified.

Figure 2.5. Antler Leister Side Point. (45SJ1, SAJH132520, Photo Courtesy Burke Museum. Ventral and dorsal views provided.)

Fish Hooks

Bone points used in fishing gear exhibit considerable morphological variation, ranging from unbarbed bipoints and unipoints to unibarb points (Suttles 1951:135-136; King 2007:26-27; Drucker 1965:17-18; Jewitt 1967:61; McMillan and St. Claire 2005; King 2007). Only unibarb points, used as the arming element of trolling hooks (McMillan and St. Claire 2005; King 2007), are examined in this thesis. As these arming elements may be side-hafted, unibarb bases can be asymmetrical. The example provided in Figure 2.6 has a symmetrical base.

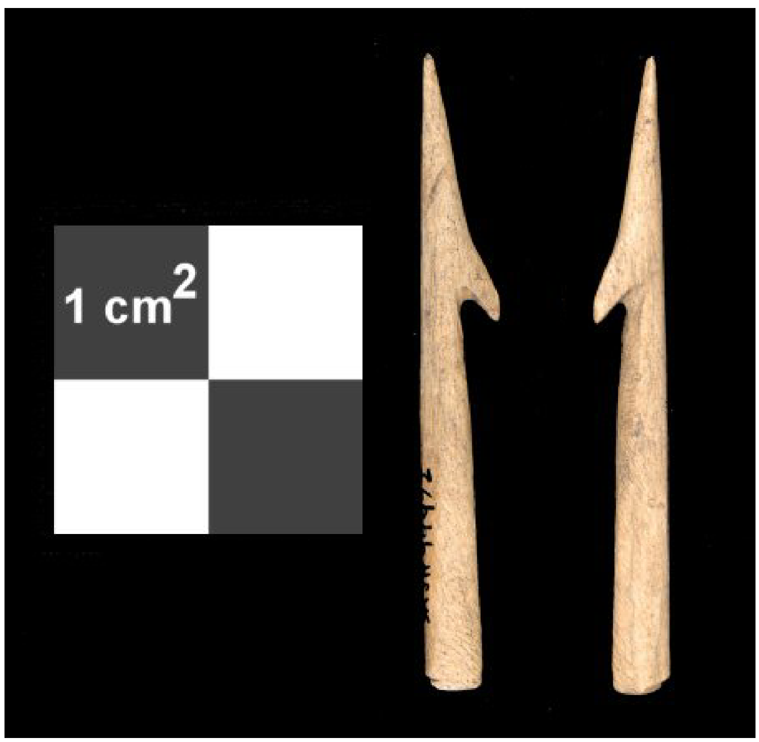


Figure 2.6. Bone Unibarb. (45SJ24, SAJH94972, Photo Courtesy Burke Museum. Ventral and dorsal views provided.)

Barbed Point System Components

The following terms, based on McMurdo (1972:32-34), Hoover (1974:7-13), and Emmons et al. (1991:107), are used to refer to components of the barbed bone and antler point projectile systems. Tanged harpoons (retrievable points) consist of all of the listed components while fixed points (non-retrievable barbed arrows and spears) consist of a head hafted to a shaft and leisters have multiple fixed points hafted to a shaft (Figure 2.1). There are also variations of composite socketed salmon harpoons with multiple heads and fore shafts (Suttles 1951:106; Arima 1983), however socketed technologies are outside of the scope of this analysis. The following terms pertain to the segments of tanged harpoon systems.

Head

A self armed point comprised of bone or antler with a tang that fits loosely into a socketed foreshaft. The harpoon head has lateral projections, notches, or perforations for the placement of a retrieving line.

Foreshaft

Present in harpoon and barbed arrow systems, the foreshaft has a socket on its distal end for the insertion of the tang. The foreshaft of most Northwest Coast tanged harpoons is a socket worked into the distal end of the shaft (socketed harpoon foreshafts have a prong). Loose foreshaft refers to when a foreshaft is a separate component fastened to both the head and shaft by retrieving lines. Loose foreshafts are used on the Northern Coast.

Shaft

Shaft length and thickness varies considerably depending on function. The distal end of the shaft of barbed arrows and harpoons is spliced or socketed to the foreshaft. Barbed arrows will have notching on the proximal end of the shaft for the bowstring, and may also have fletching. In the case of harpoons and barbed spears, a hand rest is placed on the shaft's center of gravity for thrusting. Leisters have multiple points hafted to the shaft, but otherwise have shafts similar to barbed spears.

Retrieving Line

Retrieving lines are fastened to the line attachment on the tang and tied to the proximal end of the foreshaft and distal end of the shaft using a slip collar. The line is held by the hunter, and is used to retrieve the prey.

Global and Regional Context

Barbed bone and antler points are found globally, and demonstrate a considerable degree of morphological variation. Some of the first known examples of worked bone industries and barbed bone and antler projectile technologies date from the Middle Paleolithic from sites in the Semliki valley, Zaire (Brooks et al. 1995; Yellen et al. 1995). In the past decade, additional evidence for Middle Paleolithic bone industries has also emerged from sites such as Blombos Cave, South Africa (Henshilwood et al. 2001) and Sibudu Cave, South Africa (Blackwell et al. 2008). While present during the Middle Paleolithic in Africa, Villa and D'errico (2001) argue that hafted bone points are absent from European paleolithic tool traditions and were an innovation brought to Europe by anatomically modern humans.

In the Magdalenian tool traditions (10,000-18,000 BP) of southwest Europe (de Sonneville-Bordes 1963:349-351; Julien 1982), both unilaterally and bilaterally barbed harpoons, i.e. points with a method of line attachment, are present. Unilaterally and bilaterally barbed fixed bone and antler points also appear in this period (Chard 1969:152). Controversy surrounds the function of these projectiles in the Magdalenian. Some have suggested their use in the hunting of anadromous fish, (Enghoff 1995; Verhart 1990; Jochim 1983 for evidence from rock art). However, faunal and isotopic evidence indicate that marine resources were not widely utilized until the end of the Upper Paleolithic (e.g. Schutling et al. 2007; Drucker and Henry-Gambier 2005; Bahn 1983; Mellars 1985), thus strong evidence for the procurement of anadromous fish with these technologies is lacking. During the European Mesolithic bone and antler harpoons and fish spears were utilized by the Maglemosian culture which dates to 8000-9500 BP (Braidwood 1964:83-84).

As early as 1902, Mason noted the prevalent use of barbed bone and antler points in the Americas based on archaeological and ethnographic evidence (Mason 1902). According to Rostlund's (1952) survey of North American ethnographic evidence, the greatest development of harpoon technology occurs along the eastern seaboard and Northwest Coast where harpoons vary from simple spears to complex multi-component systems. Fixed barbed bone and antler projectile points are even more widespread as they were used in the Great Lakes, the Plains, and the Southwest.

Kroeber (1923:1) and Hewes (1942:101) both indicated that barbed fish spears and harpoons were among the oldest technologies in North America, used to exploit annual salmon runs and hunt marine mammals. Hewes (1942:101) developed a general sequence of

North American Pacific Coast harpoons, starting with bilaterally barbed tanged harpoons, which were replaced by one-piece socketed harpoons. These one piece harpoons were replaced by composite socketed harpoons. More specific barbed point developmental sequences have been developed for regions of the Northwest Coast.

It is apparent from early Northwest Coast sites that harpoon technologies of one form or another have most likely been utilized during most of the human occupation of the Northwest Coast. One of the earliest known dated barbed bone points in the Americas was recovered from The Five Mile Rapids site at the Dalles, Oregon. This point is associated with the site's earliest component which dates from 9000-11000 BP (Willey 1966:399, Cressman 1960:43). The Five Mile Rapids projectile is described as a harpoon or curved harpoon prong, with shallow notches for a line attachment (Cressman 1960:43). The Lind Coulee site in Washington also contains an early barbed point, dating from 8700±400 BP (Daugherty 1956:253-255; Carlson and Magne 2008). The Lind Coulee projectile has a line attachment and thus may also be classified as a harpoon (McMurdo 1972:6).

Although barbed points are present in early contexts, until 6,000 BP on the Northwest Coast they are rare, an issue that McMurdo (1972:7) attributed to sampling as most excavations were in sites younger than 6,000 BP (McMurdo 1972:7). I argue that this is still the case over thirty years later. The sample size of barbed points in archaeological contexts increases around 5,000 BP, as barbed harpoons are present in assemblages dating to this period such as the Namu site component dated to 4550 BP (Luebbers 1978:62).

A substantial body of literature exists pertaining to the developmental sequence of harpoon technologies on the Northern Northwest Coast and North American arctic (e.g. Boas

1899; Mathiassen 1927; Collins 1937; O'Bryan 1953; de Laguna 1956; Maxwell 1985; Park 1993). The pre-Dorset peoples of the Canadian Arctic (3700-2800 BP) utilized tanged harpoons. Through the Dorset (2800-1000 BP) and Thule periods (1000 BP- Contact) socketed harpoons were utilized with the complexity of foreshaft mechanisms increasing through time (Maxwell 1985). Thule harpoons are marked by the development of 'loose shafts,' a spindle-shaped piece which is socketed to both the head and foreshaft of the harpoon which is intended to absorb mechanical stress from the movement of the prey. Maxwell (1985) argues that the development of such mechanisms reflects a transition from a generalized harpoon towards specialized ones for specific prey.

According to McMurdo (1972:120-122), the developmental sequence of harpoon technologies in the Gulf of Georgia is more complex than the sequences described above. Bilaterally barbed tanged harpoons are present during the St. Mungo period (4500-3200 BP), and are replaced by unilaterally barbed tanged, one-piece socketed, and composite socketed harpoons during the Locarno Beach period. During the Marpole period unilaterally barbed, robust, tanged harpoon forms with bilateral line attachments appear which were used by Burley (1980:24-25) as a defining trait of the Marpole cultural period.

One-piece socketed harpoons are seen in the Locarno Beach period, but are absent in Marpole assemblages (Burley 1980:25; Mitchell 1990) Burley (1980:25) cites the presence of composite socketed harpoons in sites from middle to late Marpole contexts, even though they are less represented than tanged harpoons. During the later Gulf of Georgia period, composite socketed harpoons become prevalent again while barbed points become rarer (McMurdo 1972:122). Loose shafts such as those of Thule socketed harpoons are not a characteristic of Coast Salish socketed harpoons from the historic period according to Emmons et al. (1991:108). Loose shafts do not appear to be a characteristic of prehistoric harpoons on the Gulf of Georgia either (Mitchell 1990).

Carlson (1970) proposed that the development of composite socketed harpoons indicates the intensification of maritime resource use during the Locarno Beach period. Early interpretations of this sequence hypothesized the origins of Marpole period bilateral harpoons from the interior (Borden 1950; 1951; 1954). This interpretation was later challenged (e.g. Osborne 1956) and replaced by models of in-situ development (McMurdo 1972:123-124; Carlson 1970). McMurdo (1972:123-124) asserts that while the unique attributes of Marpole period points can not be attributed to diffusion from the interior, environmental or manufacturing factors such as availability of materials may account for the development of Marpole points.

Previous Approaches

Most typological approaches to Northwest Coast bone points consist of broad categories which include a distinction between barbed points and other bone and antler point technologies (e.g. Roll 1974; Ames 1976; Dewhirst 1980; Raetz 1989; Croes 1995; King 2007). Far fewer analyses have focused on the morphological variation within bone and antler barbed points. Past analyses of Gulf of Georgia barbed points can be divided into two main categories: typological approaches focusing on culture-historical significance and functional interpretations. All of the typologies discussed below, with the exception of Hoover's (1974), pertain to non-toggling harpoons, barbed spears, leisters, and barbed unipoints. Although there have been no systematic functional analyses of Northwest Coast barbed points, functional interpretations have been developed based on ethnographic analogy (e.g. Carlson 1954).

Typological Approaches

The earliest typological analyses of Northwest Coast barbed points focused upon the northern coast, and on harpoons alone (e.g. Drucker 1943; Leroi-Gourhan 1946). Drucker's (1943:35) harpoon typology classifies harpoons as either composite or one-piece. His one-piece harpoons are tanged while his definition of composite harpoons includes both one-piece and composite socketed harpoons. Drucker's (1943:36-37) classification of one-piece harpoons (Table 2.2) focused on the overall size, cross-section, and barb morphology of each projectile with subclasses based on methods of line attachment. The terminology and types of Drucker’s scheme were adopted and modified by Northwest Coast archaeologists (e.g. Carlson 1954; Bryan 1963) and heavily influenced later typological approaches (e.g. McMurdo 1972; Hoover 1971). Two attributes examined by Drucker (1943:36-37), slotting for the insertion of microliths and staggered barb application, have been omitted from the study of barbed points on the lower Northwest Coast. While microliths do not occur in the barbed technologies of the region, staggered application of barbs is seen in St. Mungo period bilateral points and I classify this as asymmetrical barb application. As sample sizes of earlier site components increase, I propose that more barbed points with these attributes will be documented.

Table 2.2. Drucker's Northern Northwest Coast Harpoon Typology (1943: 36-37).

Type I- Points with moderate length with cylindrical or rectangular cross-sections and 1-3 high, isolated, unilateral barbs. Simple point (unslotted), with a bilateral line guard guard and a conical base.
- Subtype a- Drilled Line Hole method of line attachment
- Subtype b- Unilateral Line Attachment
- Subtype c- Rectangular Base with Bilateral Shoulders
- Subtype d- Drilled Line Hole and Bilateral Shoulders

Type II- Short heavy points with elliptical cross-sections and 1-2 low enclosed unilateral barbs. Simple point, with a slotted line hole for its method of line attachment, and a rounded base.
- Subtype a- Crescent line slot method of line attachment
- Subtype b- Drilled Line Hole
- Subtype c- Low enclosed bilateral barbs

Type III- Points with medium to long length with heavy cylindrical cross-sections and 2-4 staggered rows of low enclosed barbs. Slotted points with drilled or slotted line holes and wedged bases.
- Subtype a- Low isolated barbs
- Subtype b- Simple point (unslotted)

Type IV- Harpoon arrow points with medium to short lengths, thin elliptical cross-sections and low enclosed, isolated, barbs. Have a drilled line hole line attachment, and rounded bases.

Type V- Medium to long points with thin elliptical cross-sections and 3 or more high, isolated, unilateral barbs. Simple points with drilled line holes and wedged bases.

Drucker (1943: 39-41) also offered the first typological classification for Northwest Coast fixed straight points which lack line attachments. Drucker divides fixed points into points with and without barbs, and divided barbed fixed points into two broad categories (Table 2.3). McMurdo (1972:25) argues that Drucker's typology allows for a high degree of morphological variation within its categories. Similarly, his typology ignores points with curved profiles and so ignores functional variation.

Table 2.3. Drucker's Fixed Straight Point Typology (1943: 39-41).

Class A- Fixed points with lateral barbs	
	I- Rounded cross-section, ridged isolated enclosed unilateral barbs wedged or conical base
	II- Thin, lenticular points (two cutting edges) with unilateral or bilateral squared barbs which may be irregularly spaced, conical base.
Class B- Fixed points without lateral barbs	

The northern coast point typology developed by Leroi-Gourhan (1946:326-352) distinguishes socketed and tanged harpoons, which are defined as 'female' or 'male.' Leroi-Gourhan's classification of tanged harpoons (Table 2.4) is based upon distinctions in line attachment types and barb application. His approach places heavy emphasis on the presence or absence of drilled line holes, but largely ignores barb morphology. Agreement in barb and line attachment application (symmetry), a basis for Leroi-Gourhan's subclasses, is a trait ignored by later approaches. Attributes such as slotting and symmetry between barb application and line attachment method are uncommon in harpoons in the Gulf of Georgia, which justifies the absence of these traits in later analyses.

Table 2.4. Leroi-Gourhan's Typology (1946: 326-352).

- I- Harpoons without line holes
    - 1. Unilateral
    - 2. Bilateral
        - A. Notch on same side as barbs
            - 1. Notch on opposite side of barbs
        - B. Line guard on same side as barbs
            - 1. Line guard on opposite side of barbs
        - C. Shoulder on same side as barbs
            - 1. Shoulder on opposite side of barbs
        - D. Bilateral Notching
        - E. Bilateral Line Guard
        - F. Bilateral Shoulder
- II- Harpoons with line holes
    - 1. Unilateral
    - 2. Bilateral
        - A. Centered Line Hole
        - B. Line hole on same side as 'line swelling'
            - 1. Line hole on opposite side as 'line swelling'
        - C. Combination line hole on side of barb application
            - 1. Combination line hole on opposite side of barbs

Other typologies which have influenced approaches on the Northwest Coast include the classifications developed by Gifford (1940) and Bennyhoff (1950) both of whom focused upon the morphological traits of barbed bone and antler projectile points from the California coast. Gifford's (1940: 166; 183-184) typology (Table 2.5) divides harpoons into unilateral and bilateral subclasses with further subdivisions based on number of barbs. 'Harpoon head' refers to the entirety of the projectile, as Gifford did not subdivide barbed points into morphological segments. McMurdo (1972:23) argues that the morphological traits used for the subdivisions of this typology lack cultural-historical significance, and that attributes such as line attachment method would be more appropriate to describe the morphological variation of harpoons. Of note however is Gifford's inclusion of asymmetry, which is absent from other barbed point typologies save for Leroi-Gourhan's.

Table 2.5. Gifford's Coastal Californian Harpoon Typology (1940: 166, 183-184).

Type NN- Harpoon Head
I- Unilaterally Barbed
a. Single Barb
b. Two barbs
II- Bilaterally Barbed
a. Three symmetrical pairs of barbs
b. More than three asymmetrical barb pairs

Bennyhoff (1950: 299) divided Californian harpoons into two functional categories, large unilaterally barbed harpoons designed for sea mammal hunting and smaller unilaterally barbed harpoons for fish and small game (Table 2.6). His typology also includes tip variations for the insertion of points on the head of the harpoon. He also makes a distinction between barb shapes, not seen in Drucker's typology. Like Drucker, Bennyhoff divided bone points into categories of barbed and unbarbed types, stating that barbs were not necessarily a required functional feature of barbed spears and leisters.

Table 2.6. Bennyhoff's Coastal Californian Harpoon Typology (1950: 259).

Harpoon Class:
I. Large Unilaterally Barbed Simple Harpoons
II. Small Unilaterally Barbed Simple Harpoons
Line Attachment Methods:
A. Bilateral Line Shoulder
B. Bilateral Line Guard
C. Unilateral Line Guard
D. Line Hole
Tip Variations
1. Simple Tip
2. Slotted Tip
3. Grooved tip with inset
Barb Variations
a. Simple Barb
b. Hooked Barb

Building on Drucker's fixed point typology and Carlson's functional classes, discussed later, Bryan (1963:89) developed a classification scheme based on barb and base morphology (Table 2.7). Like Drucker he uses cross-section as one of his primary criteria for classification. Bryan's class III points are also defined by base morphology, with his hafting channeling being roughly equivalent to base thinning which this analysis defines as a wedged base (wedged in plan view, plan view being the orientation where barbs are silhouetted).

Table 2.7. Bryan's Fixed Point Typology (1963: 89).

I- Elliptical cross-section, conical base.
- a. Ridged, low enclosed barbs
- b. Low enclosed barbs
- c. High enclosed barbs

II- Broad elliptical cross-section
- a. High isolated barbs, wedged base
- b. High isolated barbs, encircling grooved base
- c. High enclosed barbs, wedged base

III- Single isolated barb, channeled for hafting

McMurdo's (1972: 39, 68, 86, 88) typological classification for Gulf of Georgia barbed bone and antler points (Table 2.8), is the most comprehensive study of barbed bone and antler points from the Gulf of Georgia region. McMurdo (1972:38) focused upon developing types which she argued had cultural-historical significance. McMurdo includes attributes defined by Drucker, and followed Bennyhoff by including barb shape. McMurdo extended her typology to include points lacking line attachments such as fixed straight points, curved profile points, and fish hooks. Two classes within Bryan's fixed point typology, types IIb and III (Table 2.7), are not considered as fixed points by McMurdo. Type IIb is a harpoon with an encircling groove (spool) line attachment, while type III falls under barbed unipoints.

McMurdo's typology for harpoons has been the commonly accepted means of classification on the Northwest Coast (e.g. Burley 1980), and is used as a basis for the traits examined. However, her typology does omit attributes such as slotted tips and staggered barb rows which were included in Bennyhoff and Drucker's classifications respectively. McMurdo (1972:38) also omits point cross-section as an aspect of her analysis. McMurdo's (1972:106) analysis placed emphasis on material used for construction as a distinction for types (see Classes III and IV), based on the belief that material use was chronologically sensitive.

Table 2.8. McMurdo's Barbed Bone and Antler Projectile Point Typological Classification (1972: 39, 68, 86, 88).

Class I: Harpoons		
	Subclass A: Bilaterally Barbed	
		Type I: Bilaterally barbed, bilateral shoulder
		Type II: Bilaterally barbed, bilateral lineguard
	Subclass B: Unilaterally Barbed	
		Type I: Unilaterally barbed harpoon w/ line guard
		Type II: Unilaterally barbed harpoons with notching
		Type III: Unilaterally barbed harpoons with shoulders
		Type IV: Unilaterally barbed harpoons with line holes
		Type V: Unilaterally barbed harpoons with compound line attachment
Class II: Fixed Straight Profile Points		
	Type I, II: Long slender antler and bone points with square enclosed barbs	
	Type III: Bone points with ridged barbs	
	Type IV: Broad bone points with wedge-shaped bases and low enclosed barbs	
	Type V, VI: Antler and bone points with serrated butts	
	Type VII, VIII: Antler and bone points with low straight extended barbs	
	Type IX, X: Antler and bone points with high extended barbs	
Class III: Fixed Points with Curved Profiles		
	Type I: Antler	
	Type II: Bone	
Class IV: Unibarbs "fish hooks"		
	Type I: Antler	
	Type II: Bone	

Contemporary with McMurdo was Hoover's (1971:33) analysis of barbed antler points from DgRw4, False Narrows (Table 2.9). Because he focused only on antler and artifacts from a single site, Hoover's typology is not as generally applicable as McMurdo's. His types are based on groupings by barb morphology, which were then tested against the chronological context of the artifacts. Artifacts which did not fit within these classes were assigned to Group V. Hoover's Group IV is similar to Drucker's class AI fixed points, although Hoover focused more on barb morphology. Groups II and IV Hoover contends have cultural significance, as the majority of artifacts within these categories date from the Marpole component of the False Narrows site.

Table 2.9. Hoover's DgRw4 Barbed Antler Point Typology (1971: 33).

Group I- Points with high or low isolated barbs
Group II- Points with low enclosed barbs
Group III- Points with high enclosed barbs
Group IV- Fixed points with isolated, enclosed unilateral barbs.
Group V- Miscellaneous

Functional Typologies

Assigning specific functions to morphological categories of bone points, in particular bipoints and unipoints, has been considered a difficult task due to their functional interchangeability in different types of composite assemblies (e.g. Drucker 1943; Ames 1976; Dewhirst 1980; Wessen 1990; Wake 2001). Barbed bone and antler points, however, have more diagnostic features such as line attachments and curved profiles which may be used to assign function. McMurdo (1972:29) suggests that functional interpretations of Northwest Coast barbed bone points have primarily extended Drucker's (1943) classification for the purposes of functional inferences. Borden (1950:16) identified points according to Drucker's classification, at the Point Grey, Marpole, and Locarno Beach sites in his preliminary report on the Fraser Delta Region. In addition, he extended Drucker's classification by defining three additional fixed barbed point types (Table 2.10). Borden defines arrow points as having wedged bases and bilateral barbs, however his emphasis on barb symmetry as a trait to define arrow points is not shared by other functional approaches (King 1950; Carlson 1954). Borden makes a distinction between curved profile points and other fixed points, associating curved points with leisters.

Table 2.10. Borden's Fixed Point Functional Typology (1950: 16).

a. Arrow Points- Points with symmetrical, bilateral, isolated barbs and with flat, parallel sided tangs. (wedged bases)
b. Heavy points with high isolated barbs
c. Leister Spear Side Prongs- Points with strongly curving profiles

Like Borden, Arden King extended Drucker's classification. King (1950:45-46) divides fixed barbed points into two categories, straight profile and bent profile points. Bent profile points are equivalent to Borden's curved points. King associates fixed points with the end points of bird darts or arrows while bent profile points are associated with leisters and the side prongs of bird darts. According to King, use-wear on the bases of fixed and bent profile points indicates that bent profile points were hafted as side points while fixed points were hafted to the end of a shaft.

Carlson (1954) provides functional interpretations of Gulf of Georgia barbed points based on regional ethnographic accounts. Carlson's (1954:24) typology for harpoons was based on size, where small harpoons were used for salmon, those of moderate size for porpoise and seal, and the largest for whales. Table 2.11 shows Carlson's types for fixed points lacking line attachments. There is overlap between Carlson's Type I points and Bryan's Type II as well as Carlson's III and Bryan's Type I. The distinction made between arrow and spear points in Carlson's (1954) analysis is not used in McMurdo's (1972) typology. However, the use of curved profile to define a distinct type is shared.

Table 2.11. Carlson's Fixed Point Functional Classification Based on Ethnographic Analogs (1954: 24).

Type I- Spear Points Large, wide points made from cervid or whale bone. Have a plano-convex cross section for attachment to a foreshaft or a thinned base for insertion in a foreshaft.
Type II- Arrow Points Long narrow points with wedged or conical butts, which are inserted into a foreshaft.
Type III- Side Points Small narrow points with a bent profile. May be used as side points or as part of a multiple pointed arrow.

A second example of ethnographic based functional analysis can be found in Hoover's (1974:11-12) typological analysis of ethnographic period harpoons. Hoover divided harpoons into classes intended to reflect both formal and functional similarity, applying ethnographic data to the examined artifacts to determine functions. Like Leroi-Gourhan, Hoover divides harpoons into socketed and tanged, focusing on socketed points. While Hoover discusses the ethnographic context of tanged harpoons, they are excluded from his analysis.

More recent, is Shannon King's (2007) functional analysis of small bone points, which she defines as bone objects with a length less than 15cm (King 2007:9). King's analysis draws heavily upon McMillan and St Claire's (2005) functional interpretations of small bone points. King uses ethnographic analogy, use-wear analysis, and descriptive statistics to examine morphological variation within and between eighteen morphological categories. There is a degree of overlap in artifact types examined between her analysis and this thesis, as King analyzed fixed barbed points and barbed unipoints less than 15cm in length. The morphological attributes of barbed points examined by King are similar to those used in this thesis, although she uses different labels. Despite this overlap in artifact types, her materials are from Western Vancouver Island and are outside the geographic scope of this analysis. King's categories and attributes were not used as a basis for this analysis.

Type and Attribute Functions

Northwest Coast archaeologists have based interpretations regarding the functions of barbed point types and attributes on ethnographic accounts and common sense inferences. The following sections discuss previous functional interpretations of barbed points and, for comparative purposes, socketed harpoons , and the hypothesized roles of specific attributes.

Type Functions

Harpoons: Tanged and Socketed

Harpoons are retrievable points, meaning that they have a method of line attachment. Harpoons, both socketed and tanged, are typically thrust, not thrown, at a target. The term 'spearing' which has been used in the literature to refer to the use of retrievable points causes confusion. I use this term only in reference to the act of using fixed straight profile points lacking line attachments (Jewitt 1967; Stern 1934; Berringer 1982).

Throughout the Northwest Coast, harpoons are argued to be multipurpose in nature, but particularly used to hunt marine mammals (de Laguna 1937; de Laguna et al. 1964; Krause 1956). Tanged harpoons were not used to hunt larger marine mammals such as whales. Tanged harpoons are often not mentioned in association with fish when discussed at all (e.g. Smith 1899; Teit 1903, 1907). Tanged harpoons are generally not fatal; they are intended to attach to prey to prevent escape with the aid of floats to prevent sinking (Ames and Maschner 1999:91-92). Clubs were utilized to kill prey that was still living when retrieved.

Composite socketed harpoons were utilized for the capture of salmon (Kroeber and Barrett 1960:74) and sturgeon (Hoover 1974:20). In the interior of British Columbia, salmon and beaver were also captured with composite socketed harpoons. Drucker (1965:11) suggests that any form of detachable point (socketed or tanged) is more efficient in capturing salmonids than fixed points. Fish while struggling would tear free from a fixed point, while detachable points allow for the free movement of the prey without letting it break free. I suggest that while composite socketed harpoons were used to capture salmon, tanged harpoons were intended for more specialized purposes.

Harpoon line attachments were often formed from nettle fiber string surrounded by a cherry bark cover (Waterman 1920:28; Suttles 1951:106). Among the Makah and Klallam, whale sinew was used to construct the line attachments for composite harpoons (Waterman 1920:31).

Fixed Points (Barbed Spears and Barbed Arrows)

According to ethnographic accounts from the Gulf of Georgia, fixed, straight profile points are multi-purpose hunting and fishing implements (Suttles 1951; McMurdo 1972). King (1950:45-46) classified fixed barbed points as fixed arrow points or the end points of bird darts. Carlson (1954:24), divides Gulf of Georgia fixed barbed bone points into spear points and arrow points. Larger straight profile points were used as spear points to hunt large mammals and fish (McMurdo 1972:111).

Kroeber and Barret (1960:74) assert that fish spears had more utility in enclosed spaces than harpoons. They observed that in northern California, fixed points were used for the capture of fish in a riverine context as retrieving a line in a river was more difficult than in open water or shore. This is echoed by Berringer (1982:37) in his discussion of Northwest Coast barbed spears, as he indicates their use for capturing salmon in specific contexts such as within traps and weirs. In the Gulf of Georgia, barbed spears were also used for flat fish in tide-water flats (Suttles 1951:124-125).

Leisters

Smaller fixed points, in addition to being used as arrows or bird darts, may have been utilized as parts of compound technologies such as multi-pronged bird spears (Kroeber and Barrett (1960), multiple pointed arrows and darts (Carlson 1954:24), or fish leisters. Side hafting is used to secure the side points of these multiple component systems. Side hafting would require a point to have either a curved profile (King 1950:45-46) or an asymmetrical base.

In Oswalt's (1976:94) survey of fishing technologies, leisters were highly circumstantial in their use. Leisters were utilized when fish were plentiful, in shallow water, and had their movement restricted such as in a tidal pool or weir. Designed to impale one fish at a time, Oswalt claims that leisters alone are an inefficient means of taking fish on a large scale. However, when combined with nets, traps, and weirs leisters are an effective tool for harvesting.

Fish Hooks

Both barbed and unbarbed bone points were used to arm trolling hooks used for the capture of a variety of species such as cod, halibut, red snapper, and salmon (Drucker 1951; Jewitt 1967; Renker and Gunther 1990). These bone points were fit to grooves within wooden shanks which could be straight or curved (Drucker 1951:22). Most ethnographic accounts describing trolling hooks mention unbarbed points (Swan 1870; Drucker 1951; Drucker 1965; Sproat 1868). However, Jewitt (1967:61) describes unibarb points used as trolling hooks during his time on Yuquot island from 1803 to 1805. According to Jewitt, these unibarbed points were inserted into the shank which was split for hafting.

Trait and Attribute Functions, Production, and Risk

Arguments regarding the functional roles of specific attributes have been made but remain untested. Gifford (1940:183) suggests that bilaterally barbed harpoons were utilized in acquiring riverine game such as fish, while unilaterally barbed harpoons were designed for hunting sea mammals. Rau (1885:20) argues that a unilateral barb application would be most effective for points with a line attachment. He claims that unilateral barbs would be less aerodynamic and would produce additional drag. However as a retrieving line would limit the range of a projectile the constraints resulting from unilateral barbs would not be an engineering problem. Rau (ibid) also asserts that bilaterally barb application would increase the effectiveness of a projectile in the water, supporting Gifford's claim that they would be used for fishing.

McMurdo (1972:112) speculates that bilaterally barbed harpoons could have a higher incidence of breakage than unilaterally barbed harpoons due to increased pressure on barbs during retrieval. Unilaterally barbed harpoons could be retrieved with less force placed on the barbs, reducing wear and the necessity of replacement. I disagree with her interpretation, as force may be more evenly distributed with bilateral barbs. A factor not addressed by McMurdo would be differential wear between barb application types during the dragging stage. I argue that barb application choice may be shaped by breakage risk during dragging and retrieval.

Whether other barb attributes such as density and shape have functional impact, or are stylistic, requires additional analysis (McMurdo 1972:112). Clark (1975:128-136) argues for the functional importance of barb morphology in the study of Mesolithic European barbed technologies. He posits that tanged harpoons would generally have isolated, extended barbs. Fixed points would, however, tend to have enclosed barbs and higher barb density than tanged harpoons.

Clark (ibid) also discusses a method for discerning fixed point function. Spears would have a larger hafting area than barbed arrows, leading to a longer or wider base. Barbed arrows would have relatively shorter and thinner bases. The importance of barb density for bird arrows is debatable. According to Barnett (1955:102) single pointed bird arrows are intended to stun the bird in flight, and are not piercing projectiles. However, barb density could have functional importance for leisters used to capture waterfowl and multi-pointed bird arrows. Denser barbs increase may the chance that these projectiles entangle feathers.

Differences in line attachment methods, McMurdo (1972:37, 114) argues, are not functional in nature but stylistic. Variation of material type is, of course, dependent on the available materials. According to McMurdo (1972:113), in Alaska terrestrial mammal bone is the most common harpoon material type, while the use of sea mammal bone is more prevalent in central British Columbia. In southern British Columbia, antler and terrestrial mammal bone are the common material types and sea mammal bone is uncommon.

Risk, mentioned in the discussion on barb application, may play a role in the overall developmental sequence of Northwest Coast barbed points and harpoons. According to Berringer (1982:38), fixed points and leisters were replaced over time by composite socketed harpoons as the primary fishing technology. Composite socketed harpoons remain secure during dragging. Their composite nature may make them less prone to breakage from retrieval. The development of socketed harpoons dates to the Locarno Beach period (3200 BP). During the subsequent Marpole period however, socketed harpoons, both one piece and composite are rare (Mitchell 1990; Matson and Coupland 1995; Ames and Maschner 1999). Composite socketed harpoons reappear in higher concentrations during the Gulf of Georgia period. If Drucker's interpretation that retrievable points are more effective than fixed points for the capture of salmon and large fish is correct, then the development of composite harpoon technologies would be highly advantageous when these resources are emphasized.

Hewes (1942:101) suggests that the development of composite socketed harpoons is one of convenience. He argues that harpoon valves are easier to produce than barbed harpoons, thus producing composite socketed harpoons would save time and energy. McMurdo's (1972:94-96, 120) sequence of bilaterally barbed tanged harpoons transitioning to unilateral tanged and composite socketed harpoons may be driven by maximizing production efficiency.

Shifting resource gathering practices are an alternative explanation for this sequence. Bilateral harpoons may indicate the acquisition of fish and riverine resources. Unilaterally barbed harpoons might be associated with marine mammals and sturgeon. Composite socketed harpoons could represent the intensified salmonid procurement and increased technological specialization.

III. EVOLUTIONARY APPROACHES TO ARCHAEOLOGY AND CULTURAL TRANSMISSION THEORY

Dunnell (1980), O'Brien (1996), and O'Brien and Lyman (2003) argue that variation in material culture can be partly explained by Darwinian processes, and the goal here is to apply an extension of Boyd and Richerson's (1985) dual inheritance theory to material culture in order to determine if the shift to prestige based society can be discerned by the patterns of stylistic change in barbed points. This chapter discusses dual inheritance theory and provides an overview of differing modes of cultural transmission, particular prestige bias. In addition, phylogenetic approaches in archaeology are reviewed.

Humans, like other organisms, adjust their phenotypes to the environment through experience and learning (Boyd and Richerson 1985:8). However, unlike most other organisms, humans transmit learned behaviors during one generation to the next generation. The dual inheritance approach integrates the transmission of both genetic and cultural information in their extension of neo-Darwinism to include culture change. ‘Culture’ is defined here as, “…information capable of affecting individuals’ phenotypes which they acquire from other conspecifics by teaching or imitation” (Boyd and Richerson 1985: 33). In other words, culture is a behavioral aspect of the human phenotype which consists of socially learned behaviors. Material culture includes physical products and changes to the physical setting that result from the behavioral activities of human beings and may also include the same manifestations and artifacts made by other animals (McGrew 1992). Artifacts in the archaeological record can be described as 'recipes' of cultural information (Riede 2008).

Humans are the most behaviorally flexible species (Barret 2001:148-150). This behavioral flexibility, or phenotypic plasticity, is partly due to the human ability to learn from experience and from others. The dual inheritance approach (interchangeably referred to as gene-culture coevolution) places emphasis on the role social learning plays in this phenotypic plasticity and can be applied to analysis of material culture.

Biocultural Evolution and Cultural Transmission Theory

The first to mathematically generate bio-cultural models of evolutionary process were two pairs of investigators: Marcus Feldman and L. Luca Cavalli-Sforza (1976) and Charles Lumsden and Edward O. Wilson (1981). Their models were derived from theoretical population genetics, which limited application by behavioral scientists (Laland and Brown 2002). However, Cavalli-Sforza and Feldman (1976) influenced the mathematical models developed by Boyd and Richerson (1985), the theoretical basis for this thesis. Their dual inheritance approach is applied here to changes in patterns of material culture in order to infer changes in social organization. Humans acquire behaviors through cultural as well as genetic transmission mechanisms (Boyd and Richerson 1985:3-4). Humans are born with the capacity for culture but cultural information is transmitted through non-genetic modes with different patterns of effect that can also include errors. The variation then faces selective pressures and some cultural traits are more successful than others (Boyd and Richerson 1985; Mesoudi et al. 2004; Henrich 2004). Tested here will be whether some of these modes of transmission are reflected in the patterns of artifact change evident from the archaeological record.

Social learning is the non-genetic transfer of patterns of skill, thought, and emotion between individuals in a population and is the most essential feature of culture (Boyd and Richarson 1985:33-35). Many factors influence the frequency of the transmission of cultural information variants within a population. These forces include selective pressures as well as the modes and mechanisms of cultural transmission. Cultural transmission is a more complex process than genetic transmission (Figure 3.1). Both share the evolutionary mechanisms of stochastic processes (genetic drift), errors (mutations), mixing and exchange after separation (gene flow) and natural selection but cultural transmission also occurs through additional unique mechanisms. (Boyd and Richerson 1985). Cultural drift, much like genetic drift, describes the ready loss of information that can occur in small populations and may explain reduced variation in aboriginal Tasmanian technologies after a demographic crisis (Henrich 2004). Cultural "mutations" include transmission error, i.e. individuals misremembering or misinterpreting information and represent different mechanisms of information loss compared to genetic mutations (Boyd and Richerson 1985). For example, the rate of 'cultural mutation' is much higher than the rate of gene mutation. Cultures are constantly mixing and interbreeding, leading to exchange of genes and cultural traits. However the processes by which genes and culture exchange are very different, and generations are far more variable in length for culture. However, the results of all of the above processes are subject to natural selection measured through differential reproduction of genes and cultural variants.

Patterns of change in material culture may reflect processes both shared and unique to culture. One of the unique processes is guided variation, defined as occurring when individuals assess the environment and select specific cultural variants for specific purposes (Boyd and Richerson 1985:94-95). Humans can rapidly adjust behavior to local conditions and this guided variation leads to directional, generally adaptive, change in behaviors which can be socially transmitted to future generations. Guided variation comes in two forms, undirected and directed. Undirected guided variation is random experimentation (Eerkens et al. 2006). Over time this results in a high degree of variation. Directed guided variation

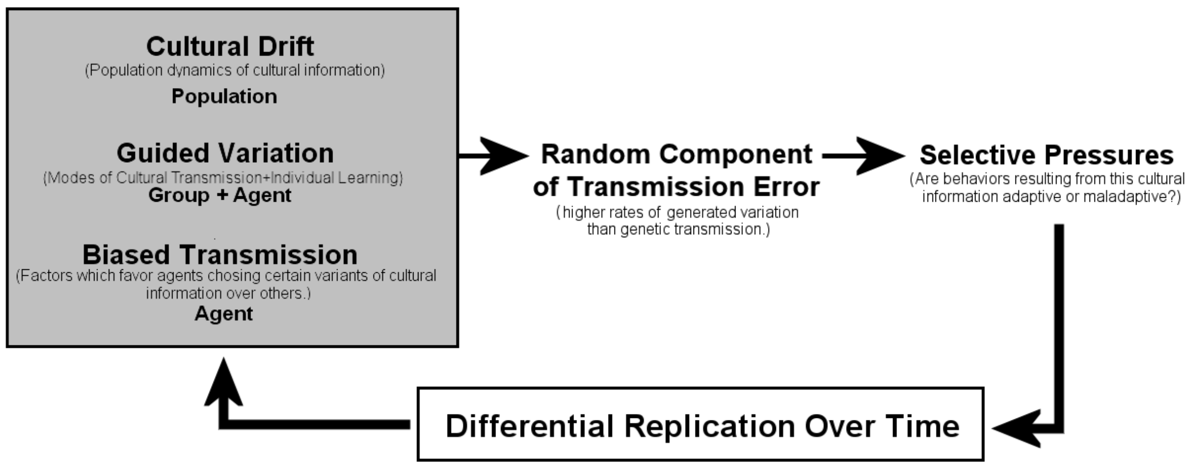


Figure 3.1. Mechanisms of Sociocultural Transmission.

occurs in situations where certain behaviors are optimal in an environment. In this situation, through experimentation individuals eventually arrive at the same conclusion, adopting the same behaviors. Another unique mechanism of culture change, transmission bias, occurs when certain behavioral variants are favored over others as a function of the transmission process itself as opposed to later selective pressures (Boyd and Richerson 1985:94-95). Direct bias describes the situation in which an individual chooses a cultural variant because of the qualities of the cultural variant. In other situations, termed indirect bias, the individual may acquire a cultural variant due to influences outside or separate from the qualities of the cultural variant as in the case of lower status individuals copying a clothing style of a higher status individual. Lastly, frequency dependent bias is the tendency to adopt cultural variants due to their common or uncommon occurrence. This tendency is generally thought to lead to an increase in the frequency of the most common cultural variants over time. Ignored in the discussion of frequency dependent bias are the strategic interactions of individuals in acquiring cultural variants. Individuals may also chose to adopt rare and novel cultural variants or 'go against the grain.'

Genetic transmission may be either vertical (parent to offspring) or horizontal (the transfer of genes between individuals, a mode present only in single-cellular organisms) (Boyd and Richerson 1985). Cultural transmission can occur vertically, horizontally and obliquely. (Feldman and Cavalli-Sforza 1976). Vertical transmission cross-generationally within the same lineage is a powerful mode of cultural information transfer because of its reinforcement by genetic transmission (Aunger 2000; Cavalli-Sforza and Feldman 1981; Boyd and Richerson 1985:49-52). Aunger (2000) argues that vertical transmission from one generation to the next within a lineage is not the most prevalent mode of cultural transmission. Horizontal transmission is the dissemination of cultural information between members of the same generation (Cavalli-Sforza 1981; Boyd and Richerson 1985:53-55). Oblique transmission occurs when cultural information is acquired cross-generationally between non-genetically related individuals.

Additional modes of cultural transmission include one-to-many when a single individual transmits cultural information to a large group and concerted transmission when group pressure to adopt a variant is exerted in the transmission of cultural information (Cavalli-Sforza 1981; Guglielmino et al. 1995). Concerted and vertical transmission are usually conservative modes of transfer, with high levels of consistency in the transmitted trait. Other modes such as horizontal, oblique, and one-to-many forms of transmission are more likely to result in recombination and innovation leading to higher rates of cultural change (Guglielmino et al. 1995).

Cultural transmission processes may favor some cultural variants above others; this force is termed transmission bias and is distinct from natural selection, which is a process that acts on cultural variants post-transmission (Boyd and Richerson 1985). Henrich and Henrich (2007:10) believe it is useful to distinguish between differing forms of biased transmission by categorizing them as either content or context biases. Henrich and Henrich (2007:10-11) use the term content bias as when individuals differentially adopt cultural variants due to their judgments about the properties of the cultural variants that make them more appealing. Cultural direct biases are when currently learned beliefs, values, and mental models are used to assess cultural variants and how well they fit within their world view. These forms of direct biases favoring particular cultural variants may reflect genetically based preferences, preferences determined by existing cultural traits, or a combination of both. All humans have an evolved preference for fat and sugar reflecting shortages of both in the prehistoric past but there are cultural preferences in how these substances are turned into preferred dishes.

Indirect (context) bias is when individuals tend to acquire cultural variants due to their association with attractive but unrelated cultural traits (Henrich and Henrich 2007:11). Prestige bias is a form of indirect bias and describes the adoption of a behavior because it is practiced by other individuals viewed as more successful or higher status.

Individuals producing tools are presumably directly instructed and also imitate others. Presumably the learner would prefer to learn from an individual who is skilled (Henrich and

Henrich 2007:11). Differing types of knowledge and abilities required are often discussed in terms of *practical knowledge* and *knowledgeable practice* (Bamforth and Finlay 2008). Bamforth and Finlay refer to these elements of skill as *connaissance* and *savoir-faire*. *Connaissance* involves cognitive understanding, strategic decision making, and abstracting future steps (Pelegrin 1990). *Savoir-faire* is defined as practical knowledge, motor skills, and practice. Skill lies within the 'intersection' of knowledge and practice according to Bamforth and Finlay (2008). Elements of both *connaissance* and *savoir-faire* (such as learning the proper strategic choices and acquiring practical knowledge in a task) are conferred through cultural transmission although the ease of acquisition may be influenced by genetic traits that influence cognition and coordination.

A wide range of cues relating to competence, success, and prestige are used for assessing which individuals are the most skilled (Henrich and Henrich 2007:12-13). These include direct assessments of skill, and indirect cues of personal prestige. Indirect cues to personal prestige are culturally-bound, but may include measures including house size, family size, volume of foodstuffs stored, or cost of a car. Henrich and Henrch argue that in certain contexts, indirect cues of status and prestige may be more accurate than direct observation especially in circumstances where the performance of an activity may be highly variable in nature. Variable performance of activities using barbed bone and antler points despite personal skill may lead to a greater influence of prestige bias. Highly skilled and successful individuals would be in high demand and individuals would have to compete for access to the most skilled individuals (Henrich and Henrich 2007: ibid). This would create a selective pressure for learners to give deference benefits to individuals viewed as more skillful in order to receive preferential access to learning. The choice of prestige as a term for this transmission bias is deliberate to indicate its non-coercive nature (Henrich and Gil-White 2001). The deference benefits given to individuals viewed as prestigious according to Gurven (2001) could range from coalition support, general assistance, public praise, child care, or gifts. Learners can take advantage of these patterns of deference to reduce the cost of information gathering (Henrich and Henrich 2007:13-14). However inherited prestige that is passed on to individuals who are not as skilled can lead to the adoption of non-adaptive or costly practices.

Henrich and Henrich address the issue of 'costly' behaviors arising from unskilled individuals as models but they do not discuss the potential of faking prestige indicators and this influence on prestige bias. Production of important tools would require learning by the next generation and a society sensitive to status might generate a different pattern of social transmission of the knowledge for how to make specific tools, in this case, barbed bone and antler points. Presumably, there would be more conformity and homogenization of tools in a society highly sensitive to a few highly skilled, high prestige, elite status tool makers.

Henrich and Henrich describe two forms of conformity which operate in differing contexts (2007:22-24). The two forms are distinguished by motivation, a factor that may not be apparent from archaeological evidence. The first form of conformist bias is informational conformity. Imagine a situation where the majority of people in a village used composite harpoons for the capture of salmon but one individual instead used barbed spears. Both the composite harpoon users and the individual using barbed spears had average catches. Which technology should be adopted? In this situation the individual using barbed spears is no more or less successful than those using the composite harpoons, and for the sake of argument this individual is also no more or less prestigious nor is viewed as a deviant for the odd choice in fishing technologies. A solution to this situation is copying the behavior of the majority because there are no clear cues which can be used to decide which cultural variants to adopt (Henrich and Henrich 2007:22).

The second form of conformist bias is termed normative conformity, and this involves adopting cultural traits in order to not appear deviant (Henrich and Henrich 2007:24). Under normative conformity, individuals tend to maintain their underlying opinions and beliefs but adapt behaviors viewed as superficial to match the norm. Informational conformist bias replaces prestige bias in situations where information regarding success or prestige is incomplete; normative conformist bias occurs when there are strong sanctions against choosing atypical cultural variants. The challenge is finding evidence for the above behavioral variants in the archaeological record.

Archaeological Implications of Cultural Transmission Theory

Cultural transmission is evident in the archaeological record because artifacts represent products reflective of transmitted cultural information (Riede 2008; O'Brien and Mesoudi 2008). Artifact variation can represent descent with modification within a single technological tradition or independent developments. Phylogenetic relationships do not exist between inanimate objects but they may partly account for the transmitted concepts reflected in the objects. Cultural information can be exchanged between ‘cultural clades,’ which are diverging branches of cultural traditions (Temkin 2007). Cultural information may also travel through time, via physical models or textual information, with previously ‘extinct’ traits being re-introduced decades or even centuries later. Temporally or spatially discontinuous cultural lineages are possible. Thus the effectiveness of methods of reconstructing phylogenies depends upon the nature of the transmission of cultural information. The relative frequencies of different modes of cultural transmission can greatly influence the utility of such techniques.

The modes of cultural transmission most likely to produce strong phylogenetic signals are conservative modes of transmission such as vertical transmission or group pressure to conform. In other words, these patterns will be stable over long periods of time and more easily reconstructed archaeologically. Horizontal and one-to-many transmission enable the rapid spread and variation of cultural variants (Guglielmino et al. 1995:75-85) but that variation will result in weak signals or patterns that are harder to reconstruct. Figure 3.2 summarizes the relationship between conservative and non-conservative modes of transmission and the ability to reconstruct phylogenies.

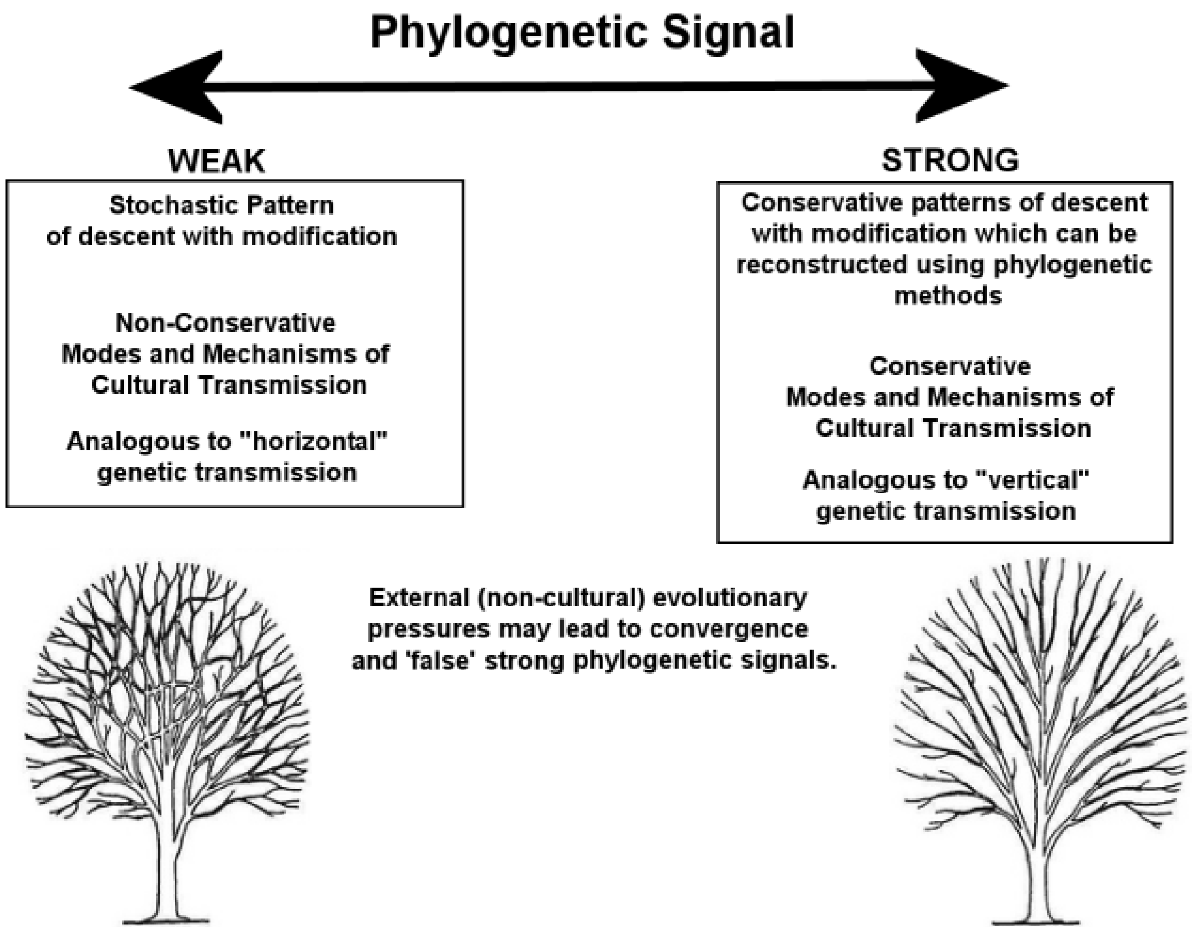


Figure 3.2. Phylogenetic Signal Strength and Implications for Reconstructing Cultural Phylogenies.
While not a dichotomy, conservative forms of cultural transmission tend to have strong phylogenetic signals while non-conservative forms result in weak signals (Stochastic and phylogenetic trees from Kroeber 1948:260).

Collard (2006:171-172) argues that conservative cultural transmission of variants is common because the human psychological literature demonstrates how individuals prefer to interact with others like themselves and to minimize contacts with perceived culturally different peoples. Archaeologists using Neo-Darwinian approaches routinely reconstruct patterns of change in archaeological cultural traditions over time using phylogenetic approaches.

Phylogenetics is defined as the sorting of taxa, units in which organisms or groups of organisms are categorized, by their common descent, using the similarity of phenotypic traits as a basis for classification (Simpson 1961). Cultural phylogenetics is based upon three assumptions: the first is that human populations, cultures, and languages are not merely analytical units but are actual entities (Terrell 2001). The second assumption is that these entities can be historically contiguous and enduring despite factors such as immigration. Finally, these entities form patterns of hierarchical descent as they have descendants and relatives. Phylogenetic analyses are most easily applied in contexts where conservative forms of transmission are pervasive.

Phylogenetic methods exploded after computers became readily accessible but that pace accelerated even more after 1985 (Felsenstein 2004:133-136). Applications to cultural data also increased (e.g., Flannery and Marcus 1983, Renfrew 1987, Guglielmino et al. 1995, Shennan 2000, Hewlett et al. 2002, Tehrani and Collard 2002, Mace et al. 2003, Shennan and Collard 2005, Holden et al. 2005, Darwent and O'Brien 2006, Atkinson and Gray 2006) due to several factors: an exponential increase in the availability of genetic data, advances in analytical and computing methods, and the willingness of social scientists to view human culture as part of the human phenotype (O'Brien et al. 2008). Culture is a product of biological evolution as much as one's prehensile hands.

Not all find phylogenetic approaches useful. Brew (1946) argued that phylogenetic methods rely on a false analogy between the transmission of culture traits and genes. Atran (2001) and Aunger (2006) criticize the lack of physical units of information transmission. Some have tried calling the units cultural transmission units (CTUs) (e.g. Lumdsen and

Wilson 1981; Wilson 1998; Hewlett et al. 2002), 'memes' (e.g. Dawkins 1976; Blackmore 1999), or 'semes' (e.g. Hewlett et al. 2002). CTUs are not genes. Sperber (2009: 9, emphasis author's) notes that: "(i) cultural variants are not *copied*: information flow is inferential reconstruction, not copying; (ii) information transfer is typically not accurate; (iii) human minds have intrinsic characteristics that make some ideas salient and memorable, and others less so." Sperber does not critique models of dual inheritance, but is critical of models ignoring the clear differences between social learning and genetic transmission. He does critique the concept of intellectual lineages, stating that genes form clear ancestor-descendant pairs while cultural transmission is a more complex process leading to different outcomes. I disagree, because, while the processes of cultural and genetic transmission vary, the long term transmission of information with a high degree of fidelity does constitute a lineage that is likely recognizable in the archaeological record (Riede 2008; O'Brien and Mesoudi 2008). For the purposes of this thesis, CTUs are defined as the minimum amount of information culturally transmitted and in this context, are categories imposed by the investigator.

Lipo and coauthors (2006) contend that the difference between cultural and genetic transmission processes is quantitative as opposed to qualitative in nature. The degree of transmission fidelity (the amount of random or non-random change in traits through time) varies, but it is their contention that the goal of phylogenetic analysis is to construct maps to track changes in information temporally and spatially and all that is necessary to begin an analysis is to determine if information has been transmitted. More conservative modes of cultural transmission, including indirect biases such as prestige bias, conformist bias and vertical bias will result in increased transmission fidelity and are more amenable to recognition through phylogenetic analyses. However, some faster paced modes of cultural evolution, which I term non-conservative, may impede the detection of any phylogenetic signals. Horizontal cultural transmission and undirected individual experimentation result in stochastic patterns and cultural phylogenies cannot be reconstructed (Eerkens et al. 2006). An additional factor that can interfere with the reconstruction of cultural transmission modes are overwhelming cultural influences during diffusion or conquest (O'Brien et al. 2008). These forms of extra lineage change will be termed 'inter-group horizontal transmission.' O'Brien and coauthors argue that external pressures for culture change can accelerate the process of change dramatically (punctuated change) making it difficult to reconstruct modes of cultural transmission.

Also affecting the reconstructed pattern is the scale of analysis; an entire culture or sub part such as a language or specific technology can be examined depending on the research question. The structure of cultural phylogenies will differ depending on the unit of analysis because the individual components of a culture may or may not evolve independently of each other (e.g. Moylan 2006). O'Brien and coauthors (2008) recommend using operational taxonomic units (OTUs) that are theoretically sound. The archaeological concept of tool traditions has been adapted by Neff (1992) to fit a cultural transmission and phylogenetic framework. Information regarding the procurement of raw material and the manufacturing process for a given technology is shared socially. The artifacts of a given tool tradition are the expression of this information in a given period of time. O’Brien and coauthors (2008) argue that technological traditions consist of lineages, single lines of ancestry and descent. The concept of tool traditions and lineages suggest a scale for OTUs, but should not restrict analyses.

A number of tools including: phyletics (Simpson 1961), phenetics (Sokal and Sneath 1963), and cladistics (Hennig 1966) have been used to classify taxa relative to their phylogenetic relationships. The goal is to reconstruct the process of evolutionary change of which there are at least three ways lineages evolve. Anagenetic evolution deals with intra-taxon small scale changes between generations (Gingerich 1985; Barnosky 1987). Eventually, the entire population differs enough that the ancestral taxon can be considered extinct. More recently, anagenesis refers to small scale changes between generations of a given taxon, which may not result in speciation (Lyman and O'Brien 2006). Cladogenesis refers to branching modes of evolutionary change which occur either when a parental taxon becomes extinct and gives rise to two daughter taxa, or a parental taxon coexists with a daughter taxa (Eldridge and Gould 1972). Reticulation involves the hybridization of two parental taxa and the interbreeding of resulting hybrid taxa with at least one parent in a manner which leads to the production of new daughter taxa (Levin 2002).

Application of these processes to cultural evolution demonstrates that cladogenesis and anagenesis are conservative modes of cultural transmission. Lyman and O'Brien (2006) argue using a small OTU may impede the detection of anagenesis versus cladogenesis. Reticulation occurs with non-conservative modes of cultural transmission.

Archaeologists have developed methodologies and adopted techniques from the biological sciences to aid in classification and inferring culture-historical relationships. For instance, phyletics was been utilized as a method in archaeological classification (e.g. Petrie 1899; Kidder 1912; Ford 1969) as a means of examining the morphological similarity of artifacts and their culture-historic relations. According to Lyman and O'Brien (2006) after the development of seriation methods by Kroeber (1916) phyletics was less used. Phyletics examines evolution of artifact styles at the scale of changes in character states among discrete objects. By contrast, seriation is used to reconstruct cultural evolution of discrete objects (Lyman and O'Brien 2006). Dunnell (1971) subdivided seriation methods into occurrence seriation and frequency seriation. Occurrence seriation was first developed by Dempsey and Baumhoff (1963) and involved the ordering of artifacts based on the presence or absence of classes. Frequency seriation (Kroeber 1916) orders cultural attributes by the relative frequencies of classes. Seriation methods and phyletic classification require external contextual information to determine, adopting a term from phylogenetics, the polarity (directionality) of the sequence.

The last two methods, phenetics and cladistics, were intended to revolutionize and make more objective phylogenetic reconstructions. Phenetics (numerical taxonomy) was utilized in archaeology for much the same purpose as in biology, to objectify and operationalize classification but its use has been critiqued (e.g. Thomas 1972). Phenetics in archaeology was utilized to discover 'natural classes' of artifacts through phenetic groupings. These groupings could then provide the 'building blocks' of a typological approach. However, according to Thomas this method is no more objective than any other because the investigator identifies traits for analysis, always an interpretive process reflecting one’s theoretical biases. Cladistics is the most popular strategy for investigating cultural transmission archaeologically in 2009 (e.g. Foley 1987; O'Brien and Lyman 2003; O'Brien et al. 2001; Collard and Shennan 2000; Tehrani and Collard 2002; Mace and Pagel 1994; Lipo 2001). It is used to detect conservative cultural transmission largely by a process of elimination. If phylogenies cannot be reconstructed, then horizontal transmission with a high degree of reticulation is assumed. Vertical transmission is assumed if a phylogeny is reconstructed. Borgerhoff-Mulder and coauthors (2006) argue that this approach is simplistic, ignoring the nuances of sociocultural transmission. I suggest that these analyses are detecting conservative or non-conservative cultural transmission, not 'vertical' or 'horizontal' transmission. 'Vertical' and 'horizontal' transmission are specific behavioral hypotheses. Following Aunger (2000), vertical transmission is likely rare in the archaeological record and other processes (indirect bias, directed guided variation) are responsible for conservative transmission. Based on models developed by Eerkens and his coauthors (2006), phylogenies may result from vertical transmission, indirect bias, or directed guided variation. Horizontal transmission or undirected guided variation can lead to reticulate patterns.

To summarize, Neo-Darwinian approaches show promise in using the archaeological record to infer modes of cultural transmission. In Chapter 5, I outline methods of using cladistics to determine conservative versus non-conservative cultural transmission and the use of Dunnell's dichotomy of style and function to account for directed guided variation.

IV. BARBED POINT TECHNOLOGIES IN ETHNOGRAPHIC AND ARCHAEOLOGICAL CONTEXTS

This chapter reviews the ethnographic literature regarding the economic and social organization of the Coast Salish, in particular the relationships between labor, resources, and status. This is followed by a discussion of ethnographic accounts regarding the relationship between individuals and prestige-based status systems and the traditional uses of barbed bone and antler points. Archaeological models and evidence for the development of social complexity on the Northwest Coast are also reviewed. The chapter concludes with expectations for the cultural transmission of barbed bone and antler points. Prestige bias is predicted to have been a major factor in the cultural transmission of barbed point manufacturing techniques. Other models for their cultural transmission are also provided.

Prestige and Status on the Northwest Coast

In ranked or stratified societies, status may be based on either dominance or prestige (Henrich and Gil-White 2001). Ethnographers generally agree that the basis of status in the Gulf of Georgia, like other regions of the Northwest Coast, is based on prestige rather than dominance. Prestige refers to freely given deference to individuals of higher status as opposed to a coercive relationship, see Henrich and Gil-White (2001). Archaeologists have argued that the archaeological manifestations of the economic and social organization typical of the ethnographic period, termed the Developed Northwest Coast Pattern, had emerged in the Gulf of Georgia by 2,000 years ago (Borden 1970; Mitchell 1971; Burley 1980; Matson and Coupland 1995). The implications of the development of this form of social and economic organization for cultural transmission modes and mechanisms has not been explored. Although freely given deference itself does not have a detectable archaeological signature, the emergence of prestige-based status on the Northwest Coast has clear material correlates, discussed later in this chapter.

Ethnographic Perspectives

Coast Salish (Figure 4.1) refers to a subgroup of the Salishan language family, the speakers of which occupied the Gulf of Georgia, Puget Sound, and southwest Washington (Kennedy and Bouchard 1990; Suttles 1990; Suttles and Lane 1990). The ranked and stratified nature of Coast Salish cultures in the historic period is well documented (e.g. Boas 1909; Gunther 1927; Stern 1934; Jenness 1934; Suttles 1951; Duff 1952; Collins 1949; Barnett 1955; Jorgensen 1969; Bouchard et al. 1975; Hill-Tout 1978a, 1978b, 1978c; Eells 1985; Kennedy and Bouchard 1990; Suttles 1990; Suttles and Lane 1990).

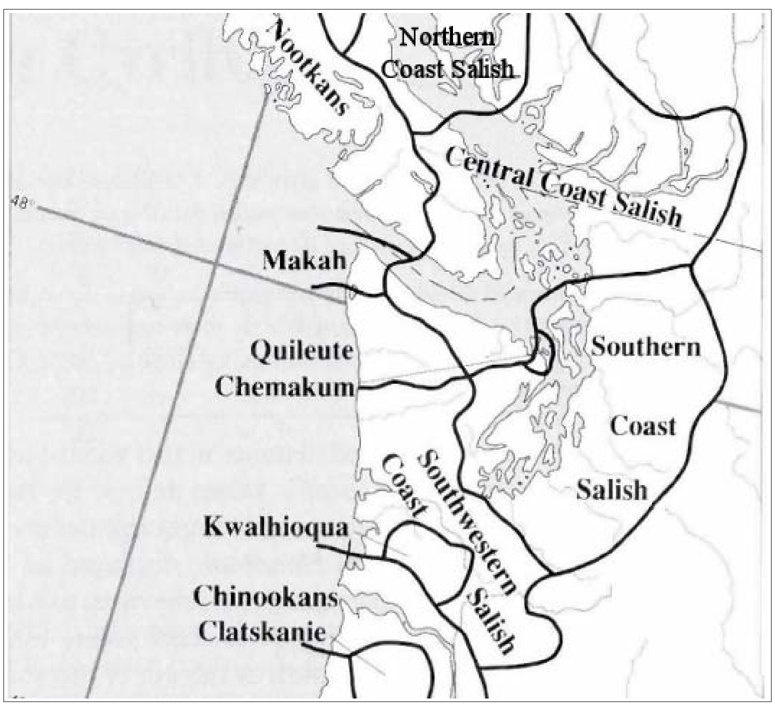


Figure 4.1. Location of the Coast Salish and Neighboring Language Groups (Suttles 1990: ix).

According to Ames (2001), Northwest Coast societies consisted of three classes: title holders, commoners, and slaves. His divisions are similar to Boas' which consisted of chief-nobles, commoners, and slaves (1909). Researchers focusing on the Coast Salish have stressed the importance of social ranking, and have avoided discussing social classes beyond the dichotomy of slaves and freemen (e.g. Drucker 1955; 1965; Suttles 1958; Elmendorf 1960; Donald 1997).

Donald (1997:196) argues that the strength of class divisions varied between groups, with class divisions being less developed in the Gulf of Georgia and Puget Sound regions compared to the central and northern Northwest Coast. The number of slaves per household varied greatly between societies of the northwest coast, with the Coast Salish having the fewest number of slaves per household in the historic period, as documented in Hudson's Bay Company censuses (Donald, ibid).

The traditional Coast Salish, using Binford's (1980) terminology, were 'delayed-return' hunter-gatherers. They utilized complex technologies for extracting and storing seasonal resources and were sedentary or semi-sedentary with high population densities. The Coast Salish have also been defined as complex hunter gatherers due to social ranking and formalized restricted access to resources (Hayden 1981; Price and Brown 1985; Testart 1982; Woodburn 1982). The status-enhancing and food resource procurement activities of the Coast Salish form a single integrated system based on kinship and inter-community marriage (Suttles 1960). These systems are discussed below in terms of the economic role of the household and village, and the relationship between status and resource ownership.

The household was the basic economic and social unit of Northwest Coast societies (Ames and Maschner 1999:147) Households consisted of corporate groups. Household size varied greatly, with some having as few as 20 people while others contained over 100 (Ames and Maschner 1999). Household labor consisted of part-time craft specialists, with tasks divided by gender roles (Ames and Maschner 1999; Donald 1997). Moss (1993) argues that these gender roles were not rigid, while Donald (1997:135) mentions they did not apply to slaves. Although tied by kinship, each specific household and village was autonomous and controlled resource sites (Richardson 1982). According to Richardson (1982), patterns of resource ownership varied greatly among Northwest Coast groups. Among northern groups such as the Gitksan of Northern British Columbia, ownership rights to land or resources not only gave one the right to use and restrict access to a resource, but also involved responsibilities (Cove 1992). Ownership rights were held by titled persons of high rank who maintained control over resource areas for their kin groups (Donald 1997: 276).

Throughout the Northwest Coast, the production of surplus food was crucial to the creation of wealth, which was used to negotiate prestige-based status between villages (Richardson 1982). Ames (2001), in his review of status and labor on the Northwest Coast, suggests that the production of large quantities of processed food, rapid construction of houses, or raiding were all means of converting labor into prestige-based status. In a prior article Ames (1981) had argued that the redistribution of individuals served as a major means of adapting to resource fluctuations. While kin groups and high status persons were bound to the resources they managed, low ranked individuals could move as necessary. Individuals would be attracted to households or villages able to display wealth, which serves as an indicator of their resource base. Thus, feasting and gift exchange allowed for the movement of the population to where resources were located. This movement of individuals means that prestige-based status attracts labor, which is then used to produce wealth, which results in further prestige-based status.

Many of the generalizations made for the Northwest Coast apply to the ethnohistoric Coast Salish. Households represented the smallest economic unit of the Coast Salish (Suttles 1951). Villages consisted of households organized by kinship (Barnett 1939; 1955). In the Gulf of Georgia, villages often had a row of large houses forming an 'ancestral' winter village which housed a core group of kin, while less-related kin were housed nearby. As population size or internal tensions increased, households would divide and form new communities (Barnett 1955:242).

Access to resources among the Coast Salish was based on affinal ties. Boxberger (1989:12) asserts that the concept of 'tribe' or 'band' was not present in Coast Salish society until groups were restricted to reservations. Instead, individuals identified with their extensive kin relationships (one could have relatives in dozens of villages). Generally, a person identified primarily with the house in which they resided. The immediate nuclear family was the basic economic unit of the household. When additional labor was required for intensive tasks, work crews could be recruited through kinship networks.

The economic organization of the Coast Salish of Haro and Rosario straits was based upon free-access resources and locations held in trust by kin groups (Suttles 1951:56). This included sites such as reef nets, weirs, or wapato ponds. Much like northern groups, these locations were controlled by individuals who granted rights to access and acted in the interest of their kin. A person had access to resource locations as far as their kinship networks extended. Boxberger (1989:13) suggests that for all practical purposes, this meant that most individuals theoretically had access to resources held by nearly all Coast Salish speaking groups through affinal connections.

Elmendorf (1971) argues that in the historic period the status relations of individuals were expressed through inter-village exchanges which enabled the social networking of Coast Salish groups and non-Salish neighbors, and high status individuals to assert and reaffirm their position. Elmendorf describes the negotiation of status for Skokomish freemen in terms of social goals and means. The first of these is a 'good birth' which would involve having two parents who originated from relatively high status families in different villages. Ideally, the parents had an elaborate marriage which involved feasting and the movement of food resources and wealth items between the families.

In addition to the ascribed status from the social context of a person's birth, Elmendorf (1971) argues that two forms of social ranking were used in Skokomish society. Both were based on a person correctly filling their role in society. From an emic perspective these roles were determined through powers obtained by guardian spirits. Personal attributes such as luck, skill, and character were tied to the individual's relationship with guardian spirits.

'Wealth powers,' a form of guardian spirit limited to individuals from high status lineages, and associated with inter-village displays of wealth and prestige-based status, is the first form of social ranking mentioned by Elmendorf (1971). For those who could attain wealth powers, developing inter-community recognition through its exercise was the next social goal. After one developed enough recognition inter-community marriage with other high status families was a means to negotiate access to resources.

The second form of ranking was less formalized. Individuals were assigned relatively informal ranks of intra-village social status based on the acquisition and use of guardian spirits and their powers (Elmendorf 1971). According to Barnett's informants (1955:78), these powers were rarely discussed directly or revealed. However, Elmendorf (1971) asserts that among the Twana, persons lacking such powers were viewed as socially irrelevant. This I suggest indicates that while the specific nature of such powers were not discussed, they were still a factor considered in the assessment of an individual's skill. Guardian spirits and their powers could be acquired by anyone and were matters of personal achievement. According to Barnett (1955:77-79), aid from guardian spirits was viewed as critical in hunting seal, halibut, and cod. It was desirable, but not necessary, in occupations that were generally productive such as salmon fishing and wapiti hunting. Spirit help was associated with personal skill and more prestigious tasks required additional spiritual aid. Barnett (1955:78) mentions that individuals could pay for training secrets with wealth items, and thus could acquire knowledge not accessible through affinal ties.

Contexts for the negotiation of prestige-based status and kinship (through inter-group marriage) were provided through feasting and gift exchange (Barnett 1955:245, 246, 250-256). This system allowed for the maintenance of inter and intra-village social networks. Inter-village exchanges enabled displays of status and rank, with inflating cycles of gifts, as well as social credit.

While the prestige-based status systems outlined above of the Coast Salish may be viewed as serving multiple purposes, it is clear that individuals are defining their own status and that of their kin. This negotiation of status, I argue, extends to the social learning of technologies used in the procurement of resources which are later converted to wealth. These systems involving the negotiation of prestige-based status and labor which have been discussed will be referred to herein as the 'Prestige Labor System.' This term specifically includes aspects of Coast Salish economic and social organization tied to the negotiation of prestige-based status between freemen, and can be considered an aspect of Matson and Coupland's (1994) 'Developed Northwest Coast Pattern.' I argue that the Prestige Labor System provides the social context for prestige bias to play a role in the social learning context of technologies tied to this system.

I suggest that the strength of prestige bias as a social learning factor is predicated on the negotiation of prestige-based status. Three factors are necessary conditions for the negotiation of status. The first is a connection between skill and prestige based status. A second factor is social mobility, individuals who become highly skilled are recognized as such and earn status. The last of these factors is access to high status persons to learn from. In regions where class divisions are less pronounced, such as in the Gulf of Georgia, I suggest that the negotiation of status may be more prevalent as there would be increased social mobility and access to high status persons for learning. Prestige bias may be a stronger factor among the Coast Salish than in groups with stronger class divisions.

The commodification of guardian spirit knowledge by highly skilled individuals discussed by Elmendorf (1971) fits Henrich and Henrich's (2007) model of prestige bias. I argue that the assessment of individual skill based on the social status gained by the acquisition and use of guardian spirits plays a greater role in the daily negotiation of status than inter-village exchange or wealth powers, and may be crucial in cultural transmission.

Clear systems of deference developed among the Coast Salish by the historic period. It is clear that non-formalized individual ranking, at least among the Skokomish, is tied to individual skill (Elmendorf 1971). The degree of deference to lower ranked individuals, is clearly less than high status persons. When examining systems of deference from a cultural transmission perspective, it is clear that prestige bias may not be a factor in the social learning contexts of many behaviors. However, control of access to resources by high status, presumably highly skilled, individuals may influence the learning context of technologies that require a high degree of skill, and are used for high value activities. Barbed spears, leisters, harpoons and barbed arrows, I argue, are such technologies.

Archaeological Perspectives

Northwest Coast archaeologists have long acknowledged the role that the large scale procurement and storage of seasonally available resources, especially salmon, have played in the emergence of sedentism and the social complexity seen in the ethnographic record (Matson 1992; Ames 1994). While there is debate as to when the social organization of the ethnographic period emerged on the Northwest Coast (Carlson 1991b; Matson and Coupland 1994; Matson 2008), it is generally agreed that by 2000 BP there is clear evidence of ascribed status (e.g. Beattie 1981; Burley and Knusel 1989; Curtin 1991; Carlson and Hobler 1993).

Explanations for the development of the social complexity along the Northwest Coast until the 1970s varied from migration, to technological adaptation, or even environmental shifts (Borden 1970:109; Carlson 1970:122). These views were replaced with models focusing on the importance of intensive salmon harvesting as the economic change leading to the development of complex social organization on the Northwest Coast (e.g. Fladmark 1975; Schalk 1977; Carlson 1983; Matson 1983; Matson 1989, 1992; Croes and Hackenberger 1988; Ames 1994).

Schalk (1977) asserts that the exploitation of salmon on the Northwest Coast as a resource is an 'all or nothing' strategy which requires the development of storage technologies and drastic changes to entire cultural systems due to the spatial and temporal variation in salmon productivity. In his argument, systems of elite leadership and ownership developed out of the necessity to coordinate salmon procurement and storage efforts.

Monks (1987) criticized the focus on salmon in resource intensification models, describing it as 'salmonopia,' and warned that this could blind anthropologists to the importance of other resources in the traditional economies of the Northwest Coast. Ames and Maschner (1999:116) assert that 'secondary resources' played an economic role as, or more important, than salmon in these economies. The role of 'secondary' resources was not overlooked in all of the aforementioned models, as Croes and Hackenberger (1988) included flatfish.

In the aforementioned models, salmon storage has been argued as a crucial factor in the development of cultural complexity on the Northwest Coast. According to Chatters and Prentiss (2005), there is clear evidence of storage throughout the Northwest Coast by 3000 BP. Matson (2008) cites the increase in the number of archaeological sites in the Gulf of Georgia after the St. Mungo period, as reported by Mitchell (1990) as a line of evidence for the emergence of salmon storage during the Locarno Beach period. He also argues for salmon storage based on salmonids being strongly represented at Crescent Beach and other Locarno Beach period sites including West Point (Larson and Lewarch 1995) and Decatur Island (Walker 2003). Carlson (1991b) and Cannon and Yang (2006) suggest the presence of a salmon storage economy before 3500 BP at Namu, placing the development of salmon storage at an earlier time than Matson suggests. However, according to Butler and Campbell's (2004) examination of faunal assemblages, there is stability through time. This stability may indicate that models of intensification are in dire need of reassessment. Finally, Matson (2008) suggests that the absence of salmonid cranial elements at Crescent Beach is an indication of storage. He argues that if processing was done on-site for immediate consumption cranial elements would be present. If salmon storage first emerged in the Locarno Beach period, there is a significant chronological lag between the development of salmon storage and the emergence of a clear elite in the Gulf of Georgia.

Indicators of Prestige-based Status Systems in the Gulf of Georgia

Archaeologists in other regions have used domestic structures to infer social organization. Matson (2008) argues that there are significant differences in settlement organization between the Locarno Beach and Marpole periods. According to Matson, Crescent Beach, Sequim (Morgan 1999), and Decatur Island (Walker 2003) are examples of Locarno Beach site components with small domestic winter structures that would be inhabited by individual nuclear families. In contrast, the winter structures of Marpole settlements consist of large, rectangular, structures built from heavy timbers and vary from single large houses to the row house style common in the historic period (Mitchell 1990).

While a storage economy may be present during the Locarno Beach period, the social organization of peoples in the Gulf of Georgia likely differed from that of the ethnographic period. The aggregation of nuclear families at the beginning of the Marpole phase may indicate the emergence of corporate groups.

Labret wear, cranial deformation, and grave goods are argued to be material correlates of status in the Gulf of Georgia. Labret wear and cranial deformation have both been used to suggest the presence of ascribed status in the prehistory of the Northwest Coast. The transition from labret wear to cranial deformation through time has been viewed as equally important, indicating a shift in social organization (Matson and Coupland 1994; Ames and Maschner 1999).

In the ethnographic period on the northern coast, labrets were worn by free and high status women (Ames 1981, Moss 1993). Labret wear has been suggested as a marker of high status in prehistory (e.g. Matson and Coupland 1994, Ames 1995, Ames and Maschner 1999). Although the earliest dated evidence of labret wear comes from an interment at Pender Canal (Cybulski 1991), with a conventional ^{14}C age of 5,100 BP, Matson (2008) argues that marine reservoir corrections are necessary due to the high (85%) percentage of the diet from marine resources (his estimate is based on data provided by Chisholm). A reservoir corrected ^{14}C date places the age of this individual closer to 3500 BP. A similarly dated interment with evidence of labret wear is found at Tsawwassen (Curtin 1991). According to Ames (1995), labret use becomes more common in the Gulf of Georgia from 3500-2000 BP.

Labrets leave clear evidence of abrasion on human dentition if worn long enough (Murray 1981; Cybulski 1993). The full number of individuals who wore labrets may be underestimated because of dental loss, although Cybulski (1993) speculates that specific tooth loss may, in fact, be due to labret-wear. Matson (1989) argues that that absence of a labret in a burial when dental abrasion is present indicates ascribed status, with labrets being heirloom items handed down within families. Ames (1995) suggests that the presence of broken labrets in non-mortuary contexts may indicate their intentional breakage and discard to maintain the value of labrets as a status indicator.

According to Ames (1995), cranial deformation has been an indicator of high status on the southern coast from the Marpole period on. Beattie (1981:57-58, 169) argues that evidence for cranial deformation dates to the Locarno Beach period, and possibly earlier, the first evidence of intentional, cosmetic, cranial deformation dates to the Marpole period. Beattie argues that evidence of lambdoidal flattening in the Locarno Beach phase, may be an unintended side effect of cradle boards. The emergence of fronto-lambdoidal flattening during the Marpole phase he argues clearly indicates the intentional use of cradle boards for cranial modification from infancy. From the Marpole on, cranial deformation becomes a trait applied to free and high status persons regardless of gender, replacing labret wear (Beattie 1981; Burley and Knusel 1989; Cybulski 1993). Matson and Coupland (1995) argue that the transition from labrets to cranial deformation corresponds with the rise of ascribed status, under the assumption that rights to cranial deformation would be restricted to elites.

However, Hill (1992:36), in his examination of burials from sites throughout the Gulf of Georgia noted that 51% of all interments examined had evidence of cranial deformation. However, it remains unclear as to how representative these burials are of the entire population. Cranial deformation was not exclusive to elaborate burials, nor a specific type of interment. Jenness in his account of the historic period Saanich, describes cranial deformation being applied to the children of elites, freemen, and slaves (Jenness 1934:59). Due to its pervasiveness in the historic period, cranial deformation is weak evidence for ascribed status.

Grave goods and shifts in burial practices are also argued to be indicators of changes in social organization (Ames 1995; Thom 1995). According to Carlson (1991b) the Pender Island site provides one of the earliest examples, predating 4000 BP, of grave goods indicating status in the Gulf of Georgia. Carlson (1991b) argues that horn spoons engraved with zoomorphic patterns near the mandibles of individuals indicates the 'ritual feeding of the dead,' which Carlson argues as evidence of respect towards deceased high status individuals. However, this is the same burial previously discussed with a marine reservoir correction estimate by Matson (2008), which, he argues, dates to the early Locarno Beach period. According to Ames (1995) grave goods become more widespread and diverse throughout the Northwest Coast after 2500 BP. Burley and Knusel (1989) argue that the interment of elaborate grave goods with children and adolescents indicate the emergence of ascribed status by the Marpole period. Gender bias in the acquisition of prestige-based status on the northern coast is indicated by three times as many males than females being interred with grave goods (Fladmark et al. 1990). This type of restriction in the acquisition of prestige-based status by gender is argued to be absent in the Gulf of Georgia (Beattie 1981; Ames 1995).

Finally, changes in burial practices have been cited as evidence for changes in social organization (e.g. Thom 1995). During the Marpole period and earlier, simple midden burial, in which individuals were flexed into position and placed in shallow pits, was the primary form of interment (Burley and Knusel 1989). Between 1500-1000 BP, during the late Marpole period, subsurface interment ends (Cybulski 1993, 1994; Burley and Knusel 1989), replaced by above ground burial in cairns or mounds with remains housed in elaborate wood boxes (Thom 1995). Focusing on burial cairns and mounds from the late Marpole period, Thom suggests that the manipulation of mortuary symbols is direct evidence of the negotiation of status. This indicates the presence of the prestige-based status systems seen in the ethnographic record.

The Development of Prestige-based Status Systems in the Gulf of Georgia

Shifts in social organization occur approximately 2500 BP with the aggregation of households (indicated by changes in structures) and the emergence of ascribed status (indicated by grave goods). I suggest this indicates the emergence of the Prestige Labor System by the Marpole period. If salmon storage is present during the Locarno Beach period as Matson (2008) argues, then the 'Developed Northwest Coast Pattern' may not have directly emerged from the development of storage as implied by Schalk's (1977) model. One possibility is a lag between the development of salmon storage and the emergence of an elite class and the aggregation of households. However, one could also argue that the development of a storage economy should have immediate impacts on a culture and that the changes in social organization that occur around 2500 BP should be seen earlier if they are directly attributable to the development of long-term resource storage. If salmon storage alone did not result in the emergence of the prestige-based status systems seen in the ethnographic period, then what triggered the onset of these changes in social organization seen in the archaeological record?

If developmental lag or the emergence of a storage economy later than Matson argues is not the reason, resource disruption could have been a critical component to the development of the prestige-based status systems of the Gulf of Georgia. Carlson (2003) discusses evidence in Coast Salish oral traditions pointing towards a connection between class-based social interaction and the development of large settlements. Carlson also discusses mention of severe food shortages in the oral record, which he ties to the need for, and development of, inter-community institutions for the redistribution of resources. The emergence of these institutions to account for food shortages could result in the Prestige Labor System.

Lepofsky and her coauthors (2005) attribute the food shortages discussed by Carlson to a drier climate during the Marpole period. This dry period would have resulted in increased resource heterogeneity in the Gulf of Georgia, thus fitting Kelley's (1995) model for hunter-gatherers, which indicates that an increase in resource heterogeneity would result in the rise of social inequality. Lepofsky and coauthors (2005) assert that the climate changes during the Marpole period may have been an important factor in the development of the complex group interactions indicative of the 'Developed Northwest Coast Pattern.' Figure 4.2 summarizes the cultural shifts between the Locarno Beach and Marpole periods argued to be seen in the archaeological record. The possible impacts of climactic change during the Marpole period on barbed technologies will be discussed in Chapter 7.

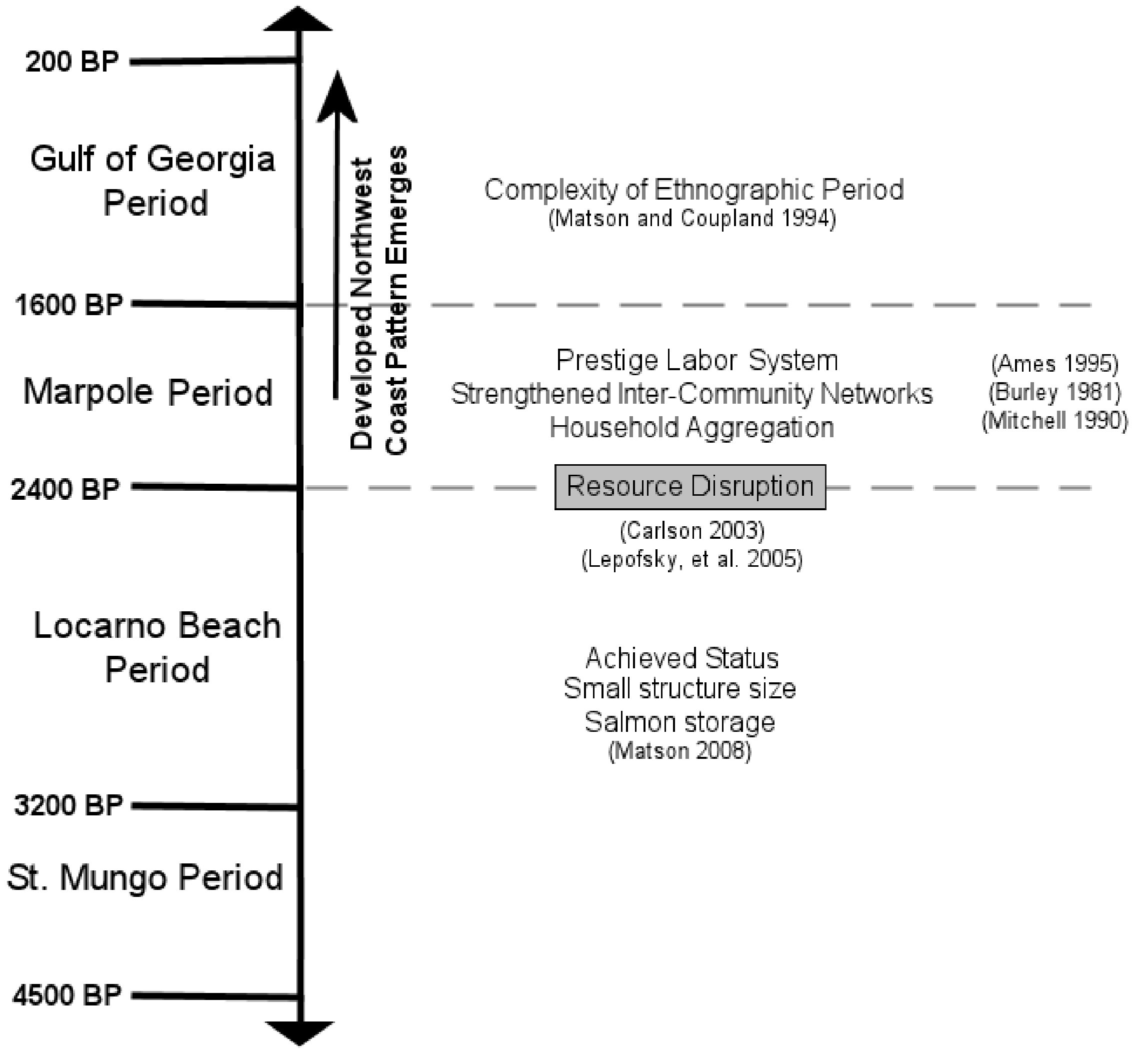


Figure 4.2. Model for the Evolution of Prestige-based Status Systems in the Gulf of Georgia.

Ethnographic Accounts of the Use of Barbed Bone and Antler Technologies

Harpoons, spears, and leisters were utilized in the historic period throughout the Northwest Coast to exploit salmon and other resources (Berringer 1982:37-38). Berringer (1982:42) argues that the importance of harpoons varied between groups, but was generally ranked below weirs and nets. He also notes that the productivity of these technologies was rarely recorded.

The use of these technologies involved a great deal of skill. According to Sproat (1868:221-222), a favorable catch by an individual, presumably one highly skilled, could consist of up to 40 salmon. The Lummi ideal for a good harpooner would be to strike the spinal column of a fish to instantly kill it (Stern 1934; Suttles 1951:141). As an example of the difficulty in using these technologies when unskilled, Jewitt (1967:88) relates in his captivity narrative that he was unable to capture a single salmon.

Nearly all groups had access to sites suitable for salmon spearing stations, which were built on the eddies and narrow channels of rivers (Berringer 1982:42). Highly valued spearing stations, such as those on the Columbia River, had overseers and six to ten other persons who also claimed rights to the site (Spier and Sapir 1930:175-176). Any of these individuals could temporarily use the best spot of the spearing station. Rights to the site were held by lineage groups, and those from other lineages were not allowed access without proper permission. The salmon streams of the Haida, Tlingit, and Tsimshan, whether island streams or tributaries of mainland rivers, were similarly controlled (Berringer 1982:42-43).

Salmon run seasonality was not the only factor influencing the use of spears and harpoons. Water clarity was crucial, and rivers such as the Fraser became too silty in the late spring for harpooning. Harpooning marine mammals or sturgeon from a boat involved two or three persons, one to steer and stabilize the canoe while the other at the bow would thrust the harpoon and give directions to the steersman (Barnett 1955:83-84).

Harpoons were also utilized in the capture of terrestrial mammals, specifically wapiti near streams, from canoes near the shore (Barnett 1955:98-102). However in these situations, arrows were more frequently utilized. Socketed harpoons were used in the capture of seal, porpoise, and beaver. Sea mammal hunting required considerable training and the sanction of high status persons (Barnett 1939). Harpoons were used against seal in two manners. The first was utilized in open water and involved the use of two canoes, each manned by two hunters. Harpoons were also used in beach hunting. Hunters when approaching seals aimed to cut off their access to water in order to ambush them with clubs (Barnett 1955:99). Harpoons were utilized as a contingency in the event that the seal escaped. Although most harpoons from the ethnographic period were composite and socketed, it is hypothesized that similar strategies were used for the procurement of marine mammals when using tanged harpoons (McMurdo 1972:109).

According to Suttles (1951:110-113) only two Coast Salish groups in the historic period actively pursued whales. These were the Quinault and the Klallam, who learned the practice from the Makah and Quileute. Makah whaling is well recorded in the ethnographic literature as a high status activity (e.g. Swan 1870; Curtis 1916; Waterman 1920; Goddard 1924; Gunther 1942; Singh 1966; Taylor 1974). Huelsbeck (1989) suggests that archaeological evidence at the Ozette site points to male harpooners as being high status specialists important to the Makah spiritual systems. Barnett (1955:92) argues that whales were not hunted on Vancouver Island or in the Strait of Georgia, although beached whales were utilized.

Spears and leisters were primarily utilized to remove fish from nets and weirs, or occasionally used to capture fish from creeks and streams (Oswalt 1976:94). Barnett (1955:79-83) claims that weirs were primarily utilized to capture salmon, while fish traps were utilized to capture a wider variety of species. These sites were controlled by an individual to a degree which varied with the complexity of its construction and the required responsibility of maintaining it (Suttles 1960). According to Suttles' informants, weir owners were able to exert more authority than, for instance, a person who controlled a tidal pond. This is because, compared to a weir, tidal ponds required less active maintenance. With tidal ponds, the extended family of the owner were allowed to take fish without the permission of the pond's owner under the proviso that they were shared. In contrast, the owner of a weir or fish trap could insist on requiring permission even from kin.

Multi-pronged spears were also used to hunt waterfowl from canoes in shallow water at night (Barnett 1955:97, 102). Single pointed barbed arrows were used to stun birds, some of which had attachments for a retrieving line. Those without retrieving lines were occasionally painted or burned for identification. While paint residue was not observed in the points examined, and should be explored in future analyses, burning was recorded.

Barbed bone points were private property, as according to Spier and Sapir, "each man fished with his own spear." (1930:175-176) Based on this, the production and use of barbed points in the historic period may be highly individualized. However factors such as resource control are potential influences on the social learning context of these technologies.

Previous Coast Salish Cultural Transmission Studies

Few studies apply cultural transmission to the Coast Salish. Croes and coauthors (2005) and Jordan and Mace (2008) have focused upon contrasting the cultural transmission of different technological systems. Croes and his coauthors' (2005) study is archaeological, while Jordan and Mace (2008) based their work on ethnographic accounts. Croes and coauthors (2005) examined the presence or absence of basketry attributes in addition to the presence and absence of basketry types in order to construct cladograms to examine the culture-historical relationships of basketry styles. For comparison, Croes and his coauthors constructed a third cladogram based on the presence and absence of stone, bone, antler, and shell artifact types from 48 site components from throughout the Gulf of Georgia.

Croes and coauthors (2005) argue that the unrooted cladogram of stone, bone, antler, and shell artifacts (Figure 4.3) divides into three main clades that roughly correspond with the Locarno Beach, Mapole, and Gulf of Georgia periods. Croes and coauthors claim that this indicates the rapid diffusion of these technologies. I argue that the fact that their analysis detected changes in assemblages which correspond with the cultural periods of the region does not necessarily indicate diffusion, but could be the effect of convergent evolution. Croes and his coauthors argue that their cladistics analysis of basketry styles indicates distinct regional styles as opposed to clustering by cultural phase. They argue that assemblages are clustered by their linguistic affiliation. This, they believe, indicates that textile styles were closely guarded and passed from mother-in-law to daughter in law in a process of conservative cultural transmission.

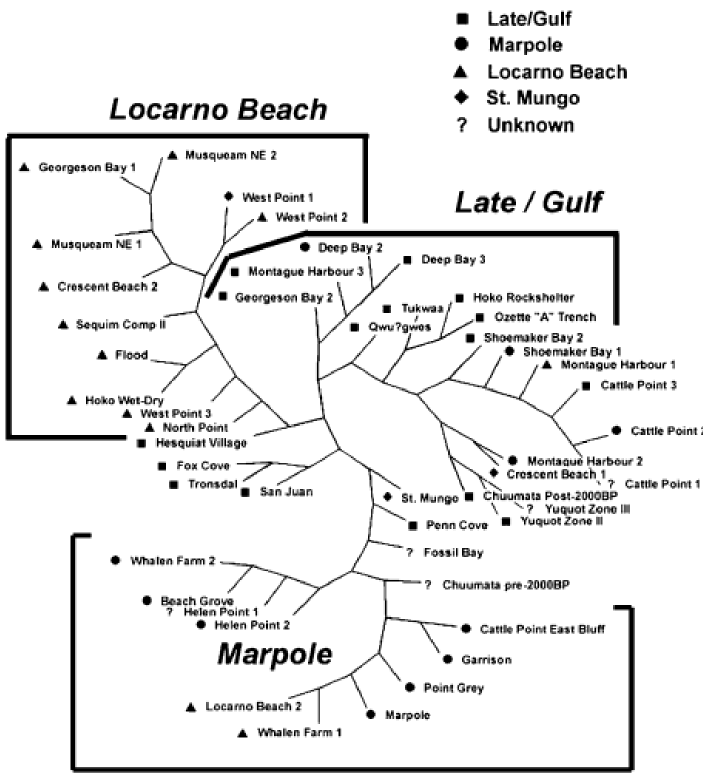


Figure 4.3. Unrooted Cladogram Based on the Presence and Absence of Stone, Bone, Antler, and Shell Artifact Types (Croes et al. 2005: 145).

Jordan and Mace (2008) examine the cultural transmission of gendered craft traditions from nine Central Coast Salish ethnolinguistic communities. They examine the presence and absence of craft traditions among these communities based on Barnett's (1939) ethnographic account. Jordan and Mace (2008) used these accounts to examine 137 traits tied to the design of structures, which they argue is a male-gendered task, and 36 traits tied to basketry which they argue is a female-gendered task. Several methods were employed in their study. Mantel matrix tests were used to examine how cultural diversity correlated with geography and linguistic affinity, correspondence analysis was utilized to examine the similarity and dissimilarity of material culture by language group, and cladistics was employed to examine whether cultural transmission was 'vertical' or 'horizontal' in nature. 'Male' cultural traits (structure design) were found to be transmitted conservatively in their study. They argue that 'female' cultural traits (textile production methods) appear more stochastic in their analysis partly due to Coast Salish residence, kinship, and property ownership being patrilocal. The argument by Croes and his coauthors (2005) that basketry styles are conservatively transmitted appears to be at odds with the findings of Jordan and Mace (2008). When viewing barbed points as a gendered technology, they would be arguably 'male' based on ethnographic evidence, and my prediction of conservative cultural transmission is in line with Jordan and Mace's results.

Model of Cultural Transmission Factors Among the Coast Salish

Prior to the emergence of the “Developed Northwest Coast Pattern,” where systems of ascribed status and prestige are not as well established, strong prestige bias is not expected. I predict a shift in cultural transmission at the beginning of the Marpole period towards prestige bias. However, there are several equifinal possibilities for the cultural transmission of technologies tied to the Prestige Labor System, such as barbed bone and antler points. The following section discusses various conservative and non-conservative cultural transmission factors, and the roles they may play in the social learning context of barbed points. Table 4.1 provides an overview of various potential transmission mechanisms, their contexts, and whether they result in conservative cultural transmission. While multiple modes and mechanisms are outlined, I argue that prestige bias is prevailing mode of cultural transmission due to the Prestige Labor System.

Table 4.1. Potential Barbed Point Cultural Transmission Mechanisms and their Contexts.

Transmission Mechanism	Context	Conservative Transmission?
Prestige Bias	Individual chooses artifact style from high status person using cues of deference from either formal or non-formal systems of prestige.	Yes
Coercive Indirect Bias	Individual forced to adopt style of high status person.	Yes
Conformist Bias	Due to the absence of clear markers of status or skill, individuals adopt the artifact style of the majority	Yes
Directed Guided Variation	Manufacturing or functional constraints reduce possible morphological variation.	No*
Undirected Guided Variation	May result from individual styles for identity marking, or the creation of a new style as a form of resistance if manufacture is in a coercive context.	No

*May appear conservative due to analogy

Prestige Bias

Prestige bias (Henrich and Henrich 2007) implies that persons may use an assessment of individual prestige as a proxy of skill. On the Northwest Coast, deference towards high status individuals in the inter-community context may not necessarily reflect their technical skill in a task such as hunting or fishing, but rather their political and social acumen. To account for this, one might use the signs of deference in order to determine which kin group is the highest in status and learn from the craft specialists of that group. For example, a high status titled head of a household may be unskilled with leisters and barbed spears, but his brother-in-law may be entrusted with a local successful fish weir and be skilled in the construction and use of leisters and barbed spears. It is predicted that individuals would choose to learn from persons assigned higher relative rank within a village. In the case of tasks viewed as more prestigious such as marine mammal hunting, prestige bias would be a stronger factor in social learning. However, even in situations where a task is not necessarily high status in nature, it is predicted that individuals would tend to model their behavior from those viewed as having higher relative rank.

Conformist Bias

If high status is not directly associated with a particular technical skill, and that skill is viewed as non-prestigious to a degree where the relative ranking for being skilled in that task is irrelevant, individuals may conform with the majority or rely on individualized experimentation. David (2001, 2003, 2007) argues that conformist bias played a strong role in the development of Maglemosian barbed points. Taking a *chaîne opératoire* (operational production sequence) approach she argues that functionally equivalent but stylistically differing points are selected from the blank stage, and notes stability in these craft traditions through time in addition to geographic discreteness in stylistic types. Although David cites conformist bias as the cause, any form of conservative transmission may have created the pattern detected. A similar pattern is expected in this analysis, although prestige bias is predicted to be the cause instead of conformist bias due to the social context.

Coercive Indirect Bias

In the scenarios discussed above, it is assumed that the social learners in question are freemen as prestige bias is based on a non-coercive relationship with higher status individuals. Ames (2006, 2008) suggests that slave labor might be used in dependable, low risk resource procurement strategies. Although the number of slaves held by individuals, on average, from groups in Gulf of Georgia during the historic period are fewer than on the Lower Columbia or northern coast (Donald 1997:196), the possibility that slaves procured resources such as salmon and produced their own bone and antler points, or that slave craftsmen produced bone and antler points for statused persons can not be entirely dismissed. While indirectly biased transmission could still occur in this situation, it would not be prestige bias due to the coercive nature of the relationship. Instead a coercion-based form of indirect bias or conformist bias could occur in this scenario, which could result in conservative cultural transmission.

Resistance and Individual Style

Resistance by slaves in the production of points and individual style have been combined as they both would result in non-conservative cultural transmission. Slaves intentionally not constructing points as specified, would effectively result in more transmission error. Taken to its extreme it could result in a stochastic pattern similar to highly individualized experimentation not subject to selective pressures, i.e. undirected guided variation.

Another possibility is that due to the wide access to resources because of the extensive nature of Coast Salish kinship groups, and the individual nature of barbed points, they may exhibit highly individualized identity markers. If the morphological variation of barbed points is attributable to individual identity marking, it is expected to result in a stochastic pattern in the cladistics analysis as well.

Expectations

While barbed point technologies demonstrate considerable functional variation and were utilized in many contexts it is predicted that they may share a common mode of cultural transmission acting on the variation in a similar manner. I argue that the pervasiveness of Coast Salish prestige systems after 2000 BP indicates that it is likely that prestige plays a clear role in the social learning context of technologies tied to the Prestige Labor System. While the potential role of slavery in barbed point production can not be completely dismissed, I argue that barbed points, at least within the Gulf of Georgia, are a technology primarily constructed by freemen and are the end result of lineages of transmitted cultural ideas which are shaped by the negotiation of status through adopting the styles of persons viewed as high status. Prestige bias, is expected to result in the conservative cultural transmission of stylistic attributes of barbed bone and antler points.

Both prestige bias and conformist transmission, as discussed in Chapter 3, will result in conservative patterns of cultural transmission amenable to phylogenetic analysis. Similarly, individual experimentation when under strong selective pressures (directed guided variation) can appear as conservative cultural transmission. Chapter 5 outlines the methods used in this analysis to avoid the detection of a 'false' phylogenetic signal caused by directed guided variation.

V. METHODS

This chapter outlines methods used to examine whether prestige bias plays a role in the social learning context of Coast Salish barbed points. A phylogenetic approach will be used to examine modes of cultural transmission. Cladistics results will be compared with simulations of modes of cultural transmission (Eerkens et al. 2006) to determine the presence of prestige bias. As strong functional pressures may result in patterns consistent conservative cultural transmission, Dunnell's (1978) definition of artifact style and function will be used to inform the selection of characters. Cluster analyses, univariate, and multivariate statistics will be utilized to examine morphological variation over time and to determine which traits were stylistic or functional in nature. In order to examine this change through time, assemblages will be assigned to 500-year BP time periods based on either mean radiocarbon dates or estimated age. These trait analyses also have the secondary goal of determining whether or not the morphological variation seen through time in this sample displays patterns noted in previous studies of Northwest Coast barbed points (e.g. McMurdo 1972; Hoover 1971).

Detecting Modes of Cultural Transmission Through Cladistics

Most applications of phylogenetics to material culture have glossed over the actual role of cultural transmission in the production of variation in material culture. Not all systems of cultural transmission as outlined by Boyd and Richerson act on variation in a manner suited for phylogenetic analysis (Eerkens et al. 2006). Indirectly biased and conformist transmission reduce variation, leading to a stronger phylogenetic signal which may be detected. However, guided variation leads to increased morphological variation through time, resulting in reticulation and a stochastic pattern. In essence, conservative modes of cultural transmission result in strong cladograms while non-conservative modes do not. The precise nature of the mode of transmission must however be decided through other contextual evidence. Riede (2008) argues that when conservative modes of cultural transmission are viewed as a null hypotheses, phylogenetic analyses are a valuable method in detecting cases where more stochastic modes of cultural transmission are at play.

Assessing the strength of a cladogram, that is deciding whether or not it indicates conservative modes of cultural transmission, involves two factors. The first is validating a tree from a manufacturing point of view, or construct validity (Leseure 1998). Second, is whether a tree is valid from a technical point of view.

Character Selection (Manufacturing Validity of a Cladogram)

For a tree to be valid from a manufacturing standpoint, characters selected for the analysis should be evolutionarily informative that is they are shared, derived, and do not conflict. Shared traits are defined as being present in two or more taxa. Derived traits are those not shared in ancestral states. This is done to avoid paraphyly, that is groups containing a common ancestor but only some descendants. Selecting derived characters is also intended to prevent symplesiomorphy (Hennig 1966), which is when two or more taxa share a character that is ancestral. The sharing of ancestral characters is not evidence that the examined taxa are more related than distant taxa. As an example, placental and marsupial mammals both having hair does not indicate a close evolutionary relationship. Finally, selected characters should not conflict, that is they are mutually exclusive. Selected characters should also come from a similar life-cycle stage or semaphoront, as discussed in Chapter 3. For phylogenetic studies of material culture a c*haîne opératoire* approach is a means of incorporating semaphoronts, as an individual stage of a production sequence is analogous to a stage in an organism's life-cycle.

Riede (2005, 2006) argues for the importance of *chaîne opératoire* in selecting informed characters, but does so in the context of viewing operational sequences as a 'recipes' which evolutionary approaches to archaeology must examine for contextual information (e.g. Schiffer and Skibo 1987; Lemonnier 1992; Keller and Keller 1996). *Chaîne opératoire* has been defined as “...the different stages of tool production from the acquisition of raw material to the final abandonment of the desired and/or used objects. By reconstructing the operational sequence we reveal the choices made by ... humans” (Bar-Yosef et al. 1992:511). For the purposes of cultural cladistics, all operational taxonomic units (OTUs) should be derived from the same stage of a tool production sequence (ex. blank, preform, finished tool).

The Dunnellian Dichotomy: Style and Function

Directed guided variation poses a considerable problem for the construction and interpretation of cladograms from an archaeological perspective. Directed guided variation, when a cultural variant is more attractive than others in the course of individual learning due to its adaptiveness, may result in a strong phylogenetic signal when the cost of failure in a task is high and there are limited optimal designs (Eerkens et al. 2006). If, for example, constructing a leister is a task that has specific functional requirements and little room for error, directed guided variation would mean that individualized learning would have a pattern similar to highly conservative forms of group learning. If the functional constraints of an artifact type are strong, one may not be able to determine if the phylogenetic signal detected is due to individualized learning with consequences or is due to conservative cultural transmission.

This issue can be circumvented through adapting Dunnell's dichotomy of stylistic and functional traits: “Style denotes those forms that do not have detectable selective values. Function is manifest as those forms that directly affect the Darwinian fitness of the populations in which they occur... The dichotomy is mutually exclusive and exhaustive.” (Dunnell 1978:199). Based on this dichotomy, only traits that are functional would be influenced by directed guided variation, although functional attributes could be influenced by other modes and mechanisms of cultural transmission as well. As strong directed guided variation and moderate to strong conformist and prestige biases are equifinal in a cladistics analysis, characters that are stylistic should be separated from those that are functional. To this end, variation in characters will be examined by functional class.

Characters demonstrating considerable morphological variation regardless of functional class, I suggest are functionally equivalent. For example, while line attachment methods clearly serve a function, multiple methods are possible. I argue that while a line attachment itself may be considered functional by Dunnell's definition, variation in line attachment methods is stylistic. Other attributes such as barb morphology may be similar. Overall, the presence of barbs on a point serves a functional purpose. However, barbs may exhibit a high degree of stylistic variation with many morphologically distinct types serving the same functional purpose.

Cladogram Interpretation (Technical Validity of a Cladogram)

The second step is ensuring that the cladogram is technically valid through the use of descriptive statistics designed to show the degree of homoplasy, characters with similarities due to convergent evolution, within a cladogram. The first of these descriptive statistics is the consistency index or CI, which measures the relative amount of homoplasy in a cladogram (Kluge and Farris 1969). Consistency index values are calculated with the formula in Figure 5.1, where M is the total number of expected character changes for a given data set, and S is the actual number of character changes which occur in a given cladogram. The total number of expected character changes for a given data set, M, is based on the theoretical minimum of character changes possible given the number of character states in the dataset. In a dataset with four taxa and two possible character states, M=4 as there is only one possible character change for each of the four taxa.

The consistency index compares expected changes in characters to the actual changes in characters in a dataset. If the actual number of character changes is high, indicating a high degree of character reversals, then this indicates a high degree of homoplasy in the dataset and a weak phylogenetic signal. Tied to the consistency index is the homoplasy index (HI) which is equal to 1-CI, which directly indicates the degree of homoplasy in a given set of characters over time.

$$CI = \frac{M}{S}$$

Figure 5.1. Consistency Index Formula.

A third descriptive statistic for cladograms is the retention index or RI (Farris 1989). The retention index was developed by Farris as a correction for the consistency index. The retention index measures the proportion of expected synapomorphies, defined as derived character states shared by two or more terminal taxa, to the actual number of synapomorphies detected in the dataset. According to Farris, CI values are lowered by autapomorphies, which are derived character states unique to a single terminal taxa and thus evolutionarily uninformitive. The retention index includes corrections that account for the ratio of detected synapomorphies to expected synapomorphies (the theoretical minimum number of possible synapomorphies given the dataset) among terminal taxa, as opposed to simply examining the total number of character changes in the dataset to expected changes.

The formula for RI is shown in Figure 5.2, where the values for M and S are the same as for the consistency index, with the addition of G which is the greatest number of steps any character can have in any cladogram produced by the dataset. An example matrix using presence/absence data with respective G values is shown in table 5.1. CI, HI, and RI values range from 0-1. With CI and RI, values closer to 1 indicate that a cladogram is a good fit to a dataset, while values closer to 0 indicate a poor fit. The inverse is true with HI values. The example dataset provided (Table 5.1) had a CI and RI value of 1.0, indicating that the expected number of changes in character states matches with the observed number of changes. According to the descriptive statistics, the data has a strong phylogenetic signal.

$$RI = \frac{(G - S)}{(G - M)}$$

Figure 5.2. Retention Index Formula.

Table 5.1. Example Cladistics Data Matrix, Derived G Values, and Descriptive Statistics.

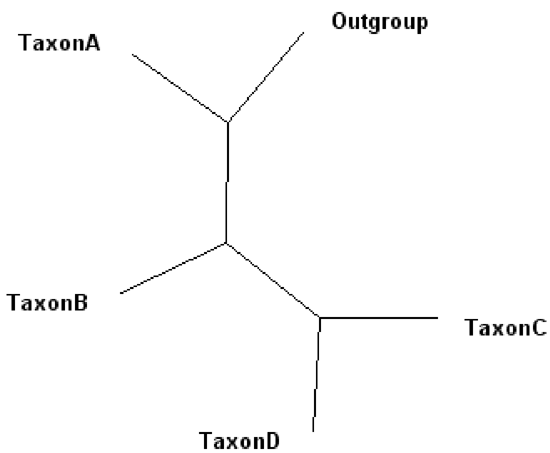
	Characters			
Taxa	1	2	3	4
Outgroup	0	0	1	0
Taxon A	1	0	1	0
Taxon B	1	1	1	0
Taxon C	1	1	0	1
Taxon D	1	1	0	1
G Value	1	2	2	2

Descriptive Statistics	
Tree Length	4
Consistency Index	1.0
Homoplasy Index	0.0
Retention Index	1.0

The structure of a cladogram may also be used to assess its strength. Cladistics software such as Phylogenetic Analysis Using Parsimony 4.0 (Swofford 1998), utilizes parsimony algorithms to search for minimum-length trees. According to Swofford, seeking the shortest tree is equivalent to seeking the cladogram with the least amount of homoplasy; this is the principle of maximum parsimony. Thus, relative tree length (TL) itself may be used as a means of assessing a cladogram. However, unlike the descriptive statistics, TL values vary with the size of the data matrix and so are not directly comparable with other statistics.

Maximum parsimony alone does not determine the directionality of a cladogram (Felsenstein 2004:4-7). For chronological order an out group must be selected. Outgroups are closely related taxa used as a hypothetical ancestor for comparison in a cladistics analysis

(Kuhner and Felsenstein 1994). Cladograms with an outgroup are termed 'rooted,' while those lacking an out group are 'unrooted.' Figure 5.3 provides an example of an unrooted and a rooted cladogram based on the single tree that resulted from the data in Table 5.1.



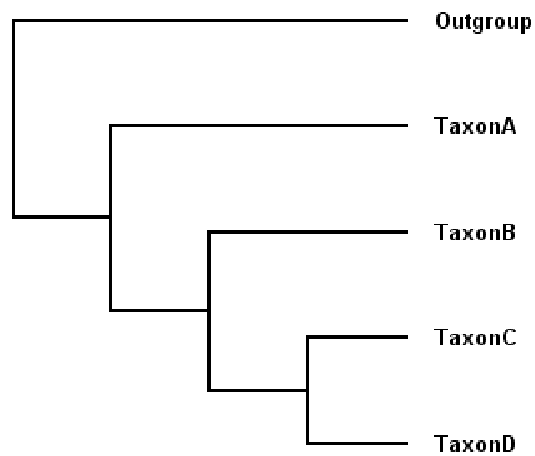


Figure 5.3. Examples of Unrooted (Left) and Rooted (Right) Cladograms.

In addition to tree length, the branching pattern of a cladogram will vary depending on the degree of reticulation in a data matrix. Provided that the characters examined are evolutionarily informative, reticulation reflects hybridization as the evolutionary relationship within the dataset. According to Nelson (1980), cladograms should exhibit multiple branches from a single node in circumstances such as the production of multiple daughter taxa, when daughter taxa are temporally isolated, or hybridization. Thus strong horizontal transmission or the reintroduction of a cultural concept would result in polytomies, sections of a phylogeny which can not be converted into a dichotomous split (Swofford 1998). Figure 5.4 demonstrates the attempts to resolve a polytomy, in this case a trichotomy.

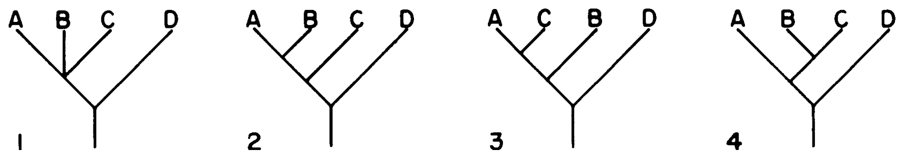


Figure 5.4. Possible Solutions to Hybridization in a Cladogram.
(Nelson 1980: 87).
Taxa A, B, and C are a polytomy.
1: Actual ancestry of a hypothetical set of taxa displayed as a cladogram
2-4: Three cladistic interpretations of the data.

According to Eerkens and his coauthors (2006), the descriptive statistics of a cladogram should vary depending on the mode of cultural transmission as guided variation, conformist transmission, and indirectly biased transmission all result in different patterns of cultural inheritance. They used consistency index and tree length values to assess the strength of a phylogenetic signal for a given simulated mode of cultural transmission (methodology discussed in Eerkens et al. 2006). Figure 5.5 displays the results of their simulations.

Based on the results of their study, there are distinctly different patterns for each of the modes of cultural transmission examined (Eerkens et al. 2006). Undirected guided variation in moderate to high levels results in stochastic patterns, while even small amounts of forms of indirectly biased transmission such as conformist transmission or undirected indirectly biased transmission result in high (>0.7) CI values. Of note however is their simulation run on directed guided variation. As the strength of directed guided variation increases, agents are more prone to adopt the same character traits due to their being more adaptive. At low strengths, directed guided variation is nearly identical to undirected guided variation. Eerkens and his coauthors argue that in environments with considerable variation where traits are differentially optimal in different places of that environment, directed guided variation erases variation due to functional constraints. This means that as the strength of directed guided variation increases, a stronger phylogenetic signal results.

Eerkens and his coauthors (2006) compared the results of their simulation with archaeological data on Elko and Rosegate style points from Owens and Monitor valleys. Individual artifacts were used as the OTU. Eerkens and coauthors expected to detect a strong phylogenetic signal and conservative cultural transmission for points from Monitor Valley. However, the resulting cladograms failed to demonstrate a strong phylogenetic signal indicative of conservative modes of cultural transmission. Eerkens and his coauthors suggest that broader scale OTUs such as artifact type may be more amenable to cladistics analysis. While the use of individual artifacts as terminal taxa in phylogenetic analysis has substantial theoretical backing, with the artifact representing the behaviors of an individual in a population (e.g. Henrich 2001; Henrich and Boyd 1998; McElreath 1997), the theoretical backing of artifact type in cultural transmission studies is more tenuous. This has not, however, prevented the use of types by archaeologists as an OTU (e.g. O'Brien et al. 2001; Collard and Shennan 2000; Croes 2003; Mace and Pagel 1994), who have argued that artifact classes can be viewed as roughly analogous to a species definition in paleontology. For this analysis, cladograms will be constructed using several different OTUs for comparative purposes and to examine which is most appropriate.

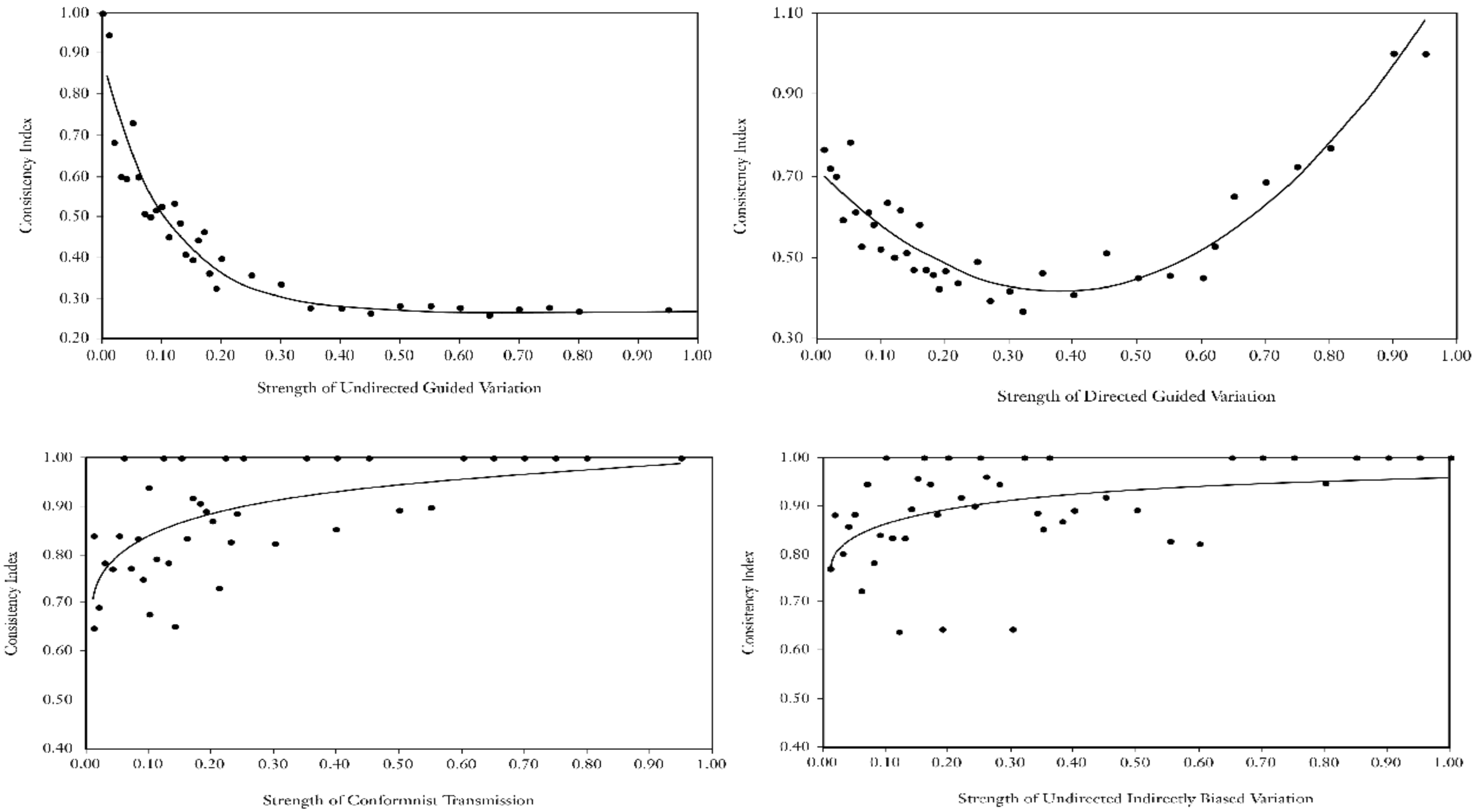


Figure 5.5. Consistency Index Values with Increasing Strength of Cultural Transmission Factors (Eerkens et al. 2006: 176-178).

Maximum Likelihood Approaches to Cladistics

While the model provided by Eerkens and his coauthors is based on parsimony approaches, maximum likelihood solutions for cladograms were also examined as an approach in this analysis. Although developed for molecular systematics, maximum likelihood has been utilized by historical linguistics (e.g. Atkinson and Gray 2006; Harmon et al. 2006). The evolutionary assumptions used by ML approaches are based on stochastic models of evolutionary change (e.g. Huelsenbeck and Bollback 2001; Swofford et al. 1996). This makes maximum likelihood approaches more suited for investigating cultural transmission, especially in cases where transmission may not be conservative in nature (O'Brien et al. 2008).

Maximum likelihood approaches for cladistics are one of the more recently developed methods of phylogenetic analysis in biology, and outperform parsimony approaches when there are unequal rates of change through time (Kuhner and Felsenstein 1994). Maximum likelihood is a model-based optimality criterion which contains explicit evolutionary assumptions (Lewis 2001). Maximum likelihood approaches use specific models of evolutionary change to identify the most likely set of relationships between taxa. The model of evolutionary change chosen gives the probability of character state changes over a certain evolutionary distance (Huelsenbeck and Bollback 2001). In essence, maximum likelihood solutions must construct trees, determine their likelihood based on the model and actual taxa, and then determine which tree has the greatest likelihood. According to Harmon and his coauthors (2006) the appropriateness of ML approaches to cultural transmission studies depends on the model used. Harmon et al. (2006) utilized a model proposed by Lewis (2001) that has unweighted characters which may freely transform between character states. This model does not emphasize graduated or punctuated change, but assumes that the rate of change for all characters is the same, which may negatively impact likelihood scores. Lewis' model is used for the ML cladistics analysis. In order to adapt an ML approach for artifacts, characters must be coded as presence/absence data (O'Brien et al. 2008). As likelihood scores are small for large data sets, the natural log of the likelihood score is used for assessment (Swofford 1998; Felsenstein 2004:259). The higher the log likelihood value is, the more likely the tree accurately reflects the data set. The descriptive statistics for parsimony cladograms are not applicable to ML approaches.

Scope and Protocols

This thesis examines the barbed bone and antler points of the Gulf of Georgia region of the Northwest Coast. The Gulf of Georgia includes the Lower Fraser River, Strait of Georgia and Northern Puget Sound, and southeastern Vancouver Island (Mitchell 1971). No chronological limitations were placed on this analysis, as a secondary goal of this analysis was to assess McMurdo's (1972) cultural historical interpretations regarding barbed point attributes, which required examining barbed points from all available time periods. In order to examine changes in attributes through time, site components were assigned to 500 year BP periods based on conventional ^{14}C dates and other age estimates. The chronological assignments of site components are discussed in Chapter 6.

Research Collections and Protocol

The scope of this analysis was limited by accessibility to research collections. All worked bone artifacts mentioned in artifact catalogs, when one was available for a site, were examined for barbed bone and antler points. In addition, level bags with faunal remains were spot-checked for worked bone artifacts and barbed points. Initially archaeological sites located in Whatcom, Skagit, San Juan, or Island counties from the collections at Western Washington University were examined. This was followed by a literature search to identify additional Gulf of Georgia archaeological sites with barbed points for examination, which led to examining barbed points from 45SJ1, English Camp, at the Burke Museum. The examination of the Burke collections was expanded in scope, and the worked bone and antler artifacts from all archaeological sites from Whatcom, Skagit, San Juan, and Island counties in the Burke collections were examined for barbed bone or antler points.

Collections from Simon Fraser University and the Royal British Columbia Museum provided materials from the southern and eastern coasts of Vancouver Island and the Gulf Islands. At the RBCM, the worked bone and antler artifacts from all archaeological sites within the geographic scope of this thesis were examined. Again, sites were included in the analysis if one or more identifiable barbed bone or antler points were found.

Initially, I had intended to re-analyze materials held at Simon Fraser University that were examined by McMurdo, in particular materials from sites such as Glenrose Cannery, Belcarra Park, and Whalen Farm. Reorganization of the collections made many of the materials difficult to access. However, materials from ElSx1 Namu, FaSu2 and FaSu10 Kwatna from the central coast, and EaSu5 from northwest Vancouver Island were analyzed for comparative purposes as well as to serve as a geographic and chronological outliers for cladistics analysis out groups. The materials from these sites were ideal for this purpose due to the large sample size and number of time periods represented. It was not possible to examine the collections at the University of British Columbia, due to extensive remodeling at the UBC Museum of Anthropology.

Barbed Point Criteria

An artifact was considered a barbed bone or antler point if a partial barb or a microbarb as defined in the non-metric characters section was present. Only finished artifacts were analyzed to ensure that all objects were from the same stage in the production sequence. David's (2003) *chaîne opératoire* analysis of Mesolithic barbed points was used as a basis for determining finished artifacts from blanks or preforms. Blanks and preforms were recorded and photographed.

Analytical Rigor

Before measuring the Burke, RBCM, and SFU collections, the artifacts from three of the sites in the WWU collections, 45WH1 Cherry Point, 45WH17 Semiahmoo Spit, and 45WH34 Ferndale were measured twice, independently, in a three month period. Analysis shows an error rate of 0.1mm when using the same calipers. Consequently the same caliper was used at each institution where collections were examined. Attempts were made to refit fragmentary artifacts, and for the purposes of this analysis refits were treated as one artifact in the recording of sections present. Non-metric characters from 45WH1, 45WH17, and 45WH34 were also examined twice independently to ensure consistency in my classification.

Photography Protocols

Photographs were taken of all measured artifacts. Each artifact has a plan view image taken of its ventral and dorsal faces. Photographs of all complete artifacts are organized by site and artifact number in Appendix E. DVDs with the raw photographs taken for this analysis are on file at the Western Washington University, the Burke Museum, Royal British Columbia Museum, and Simon Fraser University.

Morphological Attributes

McMurdo's (1972) typological analysis was used as a starting point for choosing morphological traits to examine. However, McMurdo's thesis and other previous analyses of northwest coast barbed bone and antler points have not included exhaustive examinations of metric characters. Previous approaches have consistently measured the gross length and width of the projectiles, with some analyses such as Burley's (1989) and Mitchell's (1981) including thickness. Appendix C includes a comparison of measurements taken in this analysis to previously published measurements of artifacts. This analysis includes additional measures such as barb extension and line attachment width in order to examine the possible relationships between morphological traits. Similar to Riede's (2008) analysis of Maglemosian harpoons, the barbed bone points examined have been divided into analytic segments in order to use fragmentary artifacts for an increased sample size.

While there has been substantial literature concerning bone tool assemblages and production processes, (e.g. Semenov 1964; Yesner and Bonnischen 1979; Davis et al. 1983; Campana 1989; Knecht 1991; Dugas 1996; Knecht 1997; Pokines 1998) primarily emerging from the European paleolithic, data on taphonomic processes affecting bone tools is primarily speculative. It is however believed that the linear antisotrophic arrangement of both bone and antler cells would result in most post-depositional breakage being latitudinal (the short axis). The analytic segments used should reflect the common breakage patterns of bone and antler barbed points. Figure 5.6 displays the analytical segments of barbed bone and antler points, and how they differ by functional class (Table 2.1).

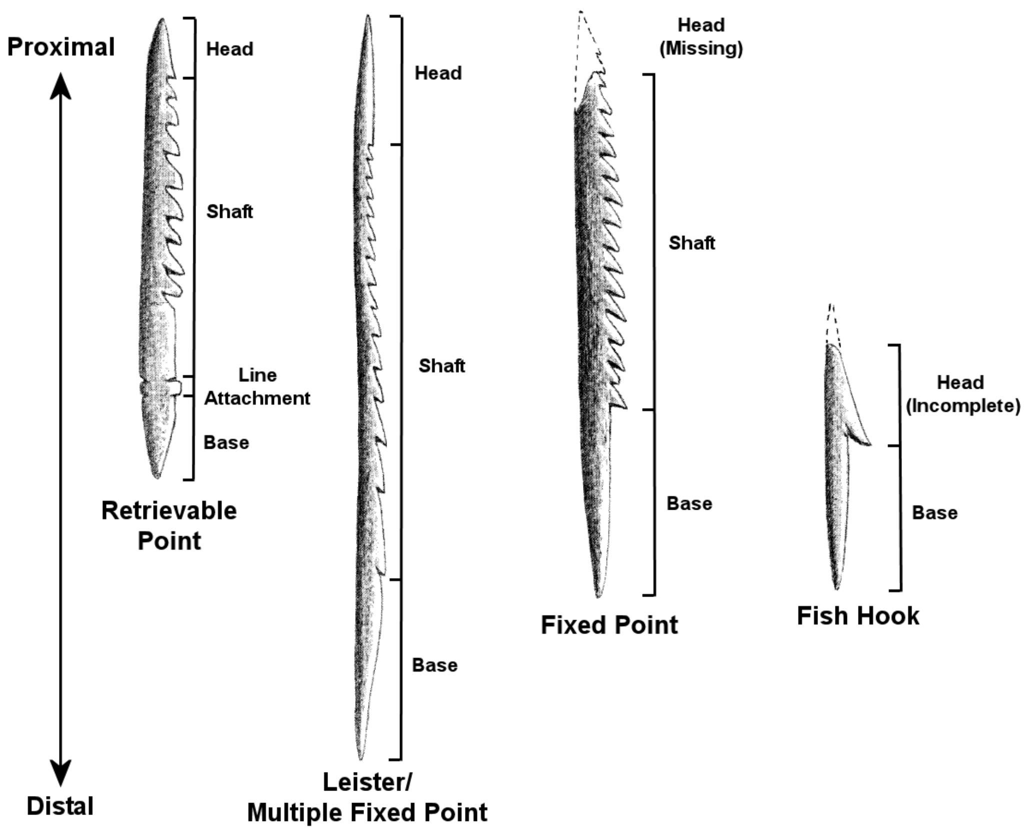


Figure 5.6. Barbed Bone and Antler Point Segments by Functional Class (Segment classification added to line drawings from Stewart 1973: 104, 106).

The nature of these artifact types also means that some types, such as fish hooks and fixed points, require more complete artifacts for identification than others. For instance, a retrievable point requires only a line attachment fragment for positive identification. Leisters or multiple fixed points can be identified by either an asymmetrical base fragment and having more than one barb, or by having a shaft fragment of sufficient length to determine that it has a curved profile. A quarter of the shaft was deemed sufficient for this purpose. Similarly, fish hooks require enough to eliminate the possibility that it is a shaft fragment of a fixed point. Fixed points however require a complete base and 25% of the shaft in order to rule out the possibility of being either a retrievable point or a multiple fixed point.

The functional classes in this analysis ignore the distinction made in Carlson's (1954:24) ethnographically based classes for barbed bone and antler points. Carlson's classification would divide the class of Fixed Point into 'Spear Points' and 'Arrow Points.' The distinction made involves examining the cross-section of the points, as 'Spear Points' have a plano-convex cross section or a base anteriorly-posteriorly thinned or wedged. As cross-section and a distinction between anterior-posterior and lateral wedging were not included in this analysis, the distinction between these two types is not made in this analysis. Carlson's 'Side Points' however fall under the category of Leister/Multiple Fixed Point.

Projectile Segment Definitions

The presence and absence of projectile segments was recorded for all artifacts. Only artifacts including all segments for their functional type when refitted were considered complete artifacts. In addition to this requirement, over 90% of the total artifact needed to be present to be considered complete. Projectile segments such as the head and shaft were diagnostic of the artifact being a barbed bone point. Similarly line attachments are morphologically distinct. However, base fragments are more difficult to positively identify as a barbed point, especially conical bases. The conical bases of unipoints show overlap in size with small bone points, making distinction between fragmentary specimens of these types difficult. A similar issue of identification occurs with lenticular profiled barbed points which are difficult to distinguish from the bases of bone tools such as awls. Because of these issues in distinguishing barbed point base fragments from other bone and antler tools, only fragments that could positively be identified as flanged or wedged bases (which I argue are morphologically distinct and more likely to be a fragment of a barbed point) were included in the analysis.

Head

The head spans from the distal end of the projectile to the proximal termination of the first barb. As discussed in Chapter 2, while the term 'head' has been used to refer to barbed points in relation to its complete projectile system (e.g. Hoover 1974), in this analysis it is used only to refer to this specific segment of a barbed point. This has been included as a separate segment due to possible functional differences between the head barb and shaft barbs as the head serves as the arming element for the projectile.

Shaft

Alternatively referred to as the shank (e.g. McMurdo 1972; Hoover 1971; Bennyhoff 1950; Drucker 1943; Leroi-Gourhan 1946), the shaft spans from the proximal termination of the first barb, to the line attachment if present. If a line attachment is absent, the shaft ends with the proximal termination of the last barb of the point. Barbed unipoints with a line attachment are considered as having a barbless shaft. See Figure 5.8 for an example of a point lacking shaft barbs.

Line Attachment

Line attachments are lateral projections or perforations for the attachment of a retrieving line on the tang (Hoover 1974), the tang being the projection at the proximal end of a harpoon for the insertion in a foreshaft with a distal concavity. Line attachments display considerable morphological variation, discussed under the non-metric characters section of this chapter.

Base

Also referred to as the tang, this is a projection at the proximal end of a barbed point for the insertion in a foreshaft with a distal concavity (Hoover 1974:6-7). For points lacking a shaft and line attachment, such as unipoints, the base begins with the proximal termination of the first barb. In the case of projectiles lacking a line attachment, the base begins with the proximal termination of the last barb. Finally, for projectiles with a line attachment, the proximal termination of the line attachment marks the beginning of the base. In all cases, the proximal end of the projectile forms the end of the base.

Non-Metric Characters

Material Type

A distinction was made between bone and antler, to test McMurdo's (1972:119) hypotheses regarding the historical significance of material type. However no distinction was made between terrestrial mammal bone and marine mammal bone. Both McMurdo (1972:32) and Burley (1989) distinguished between terrestrial and marine mammal bone, but no methods for identification were stated. Although cell size has been used as a method to determine whether worked bone is from a marine or terrestrial mammal (Personal Communication Keddie 2008), this was viewed as too subjective as it is able to discern only that the worked bone originated from a large mammal which can include terrestrial species such as *Cervus elaphus*.

Fire Modification

Fire modification was recorded as either absent, burned (charred or blackened), or calcined (higher temperature fire which turns the bone white).

Parallel Barb Groove

This is a worked groove in the material, parallel to the application of the barbs. This was recorded as it may be tied to the use of iron tools in the historic period (Personal Communication Keddie 2008).

Figure 5.7. Antler Point with Parallel Barb Groove (FaSu10, Cat. #665, Photo Courtesy Simon Fraser University).

Microbarbs

Gail Thompson (1978) in the unpublished research notes for her dissertation, made note of differences in individual stylistic markings on the barbed bone and antler points in her survey. Thompson distinguished between grooved and notched marks. Both types of marks have been termed 'microbarbs' in this analysis (Figure 5.8).

Notched Microbarbs

Notched microbarbs are incisions on the lateral surfaces of the projectile, located on barbs or the shaft of the projectile (Figure 5.9).

Grooved Microbarbs

Grooved microbarbs involve removing material through grinding (Figure 5.10).

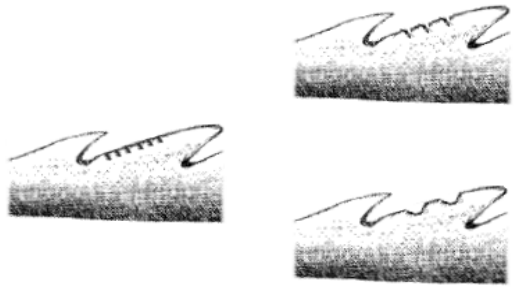


Figure 5.8. Microbarb Type (Microbarbs added to original line art by Stewart 1973: 104).

Figure 5.9. Shaft Fragment with Notched Microbarbs on Opposite Side of Barb Application (45SJ1, SAJH132382, Photo Courtesy Burke Museum).

Figure 5.10. Grooved Microbarbs and Ridged Shaft Barbs (45SK59a, Cat. #227 Photo Courtesy Burke Museum).

Head and Shaft Barb Symmetry

Barb symmetry, also referred to as barb application, may be bilateral with barbs applied on both sides of the point, or unilateral where barbs are applied on one side of the projectile (Figure 5.11). This analysis examines the application of barbs for both the head and shaft segments of a projectile. If either the head or shaft demonstrate bilateral symmetry, the point as a whole is considered bilateral for the purposes of analysis. Points with differing head and shaft symmetries are uncommon.

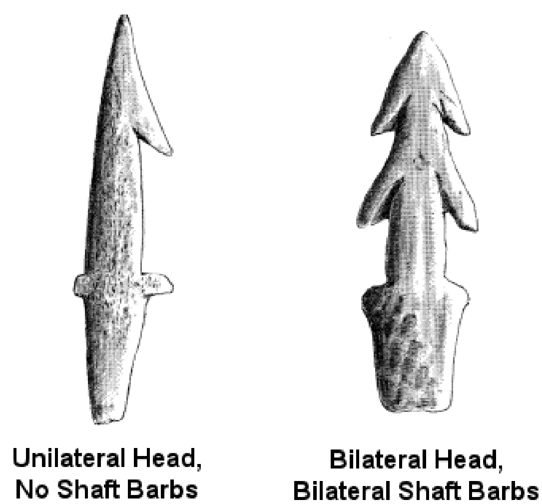


Figure 5.11. Examples of Barb Application (Line Art from Stewart 1973: 104).

Degree of Barb Asymmetry

This character is applicable only to bilateral points. This is based on the count of barbs which do not align in their positions on the shaft. As there is a maximum of two head barbs for a bilateral point, this character is counted as presence/absence for the head. Figure 5.12 shows an example of barb asymmetry. The count of asymmetrical barbs used is the lesser count. Barb asymmetry is a relatively rare trait, and is a more common trait among points older than 2500 BP.

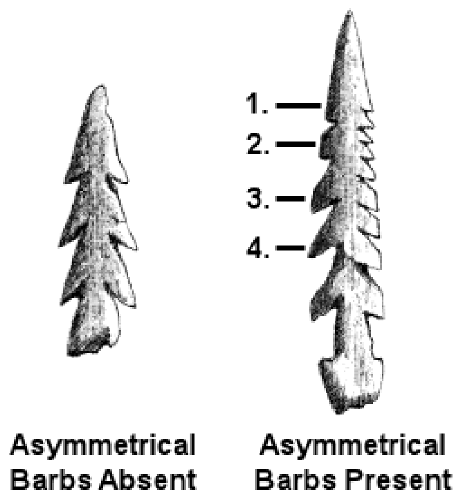


Figure 5.12. Degree of Barb Asymmetry (Line Art from Stewart 1973: 104). The asymmetrical point has Head Asymmetry as 'Present' and a 'High' Degree of Shaft Asymmetry.

Head and Shaft Barb Silhouette

Barb silhouette is defined by McMurdo (1972:33) as being either enclosed or extended in nature. Enclosed barbs are defined as barbs contained within the silhouette of the artifact (Figure 5.13), while extended barbs stand out from the silhouette. To clarify this definition for the purposes of this analysis, enclosed barbs do not modify the silhouette of the artifact while extended barbs do.

Figure 5.13. Fixed Point with Low, Enclosed, Squared Barbs (45SJ1, SAJH132847, Photo Courtesy Burke Museum).

Figure 5.14. Shaft Fragment with High, Extended, Squared Barbs (45IS31, Cat. #34, Photo Courtesy Burke Museum).

Head and Shaft Barb Extension

Barb extension may be either low or high. When the width of a barb is less than the width of the shaft, the barb is considered low (Figure 5.13). High barbs (Figure 5.14) have the same width, or greater width than the shaft (McMurdo 1972:33). Low barbs are defined as having a maximum barb width/maximum segment width ratio or less than 0.5. High barbs have a ratio of 0.5 or greater.

Head and Shaft Barb Shape

Barbs shape falls under three categories: straight, squared, and convex barbs (Figure 5.15). Straight barbs are barbs which are straight edged or slightly concave or convex.

Squared barbs are squared in plan view (and are generally enclosed barbs). Convex barbs have an outer edge which is convex to a degree where it is almost hooked (McMurdo 1972:34). This analysis records barb shape for both the head and shaft segments.

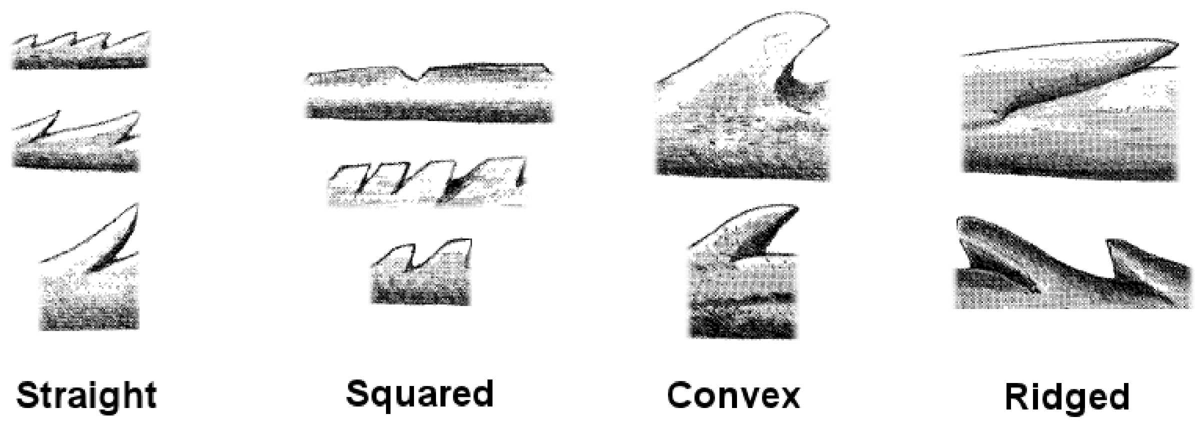


Figure 5.15. Barb Shape (Original line art from Stewart 1973: 104-106). Examples of straight barbs with a ridge present are provided on the right.

Head, Shaft Ridged Barbs

Ridged barbs include a ground surface between barbs which appears to be an extension of the lateral surface of the barb (Figure 5.15, 5.16). I hypothesize that ridged barbs are a form of ornamentation in the same vein as microbarbs.

Shaft Barb Frequency

Dense barbs are defined by McMurdo (1972:33) as numerous barbs closely spaced together (Figure 5.17) while isolated barbs are spaced widely apart with the size of the barbs being less than the space between them (Figure 2.3). Barb frequency is recorded as either dense or isolated. Barb frequency is measured only on the shaft and on artifacts with two or more barbs. For this analysis, barbs are considered dense when the space between barbs is less than the length of a barb. Barbs are considered isolated when the space between barbs is equal to or greater than the length of a barb. The space between the head barb and the first

Figure 5.16. Head and Shaft Fragment with Ridged Barbs (45SJ1, SAJH132486, Photo Courtesy Burke Museum).

Figure 5.17. Head and Shaft Fragment with Squared Low, Enclosed, Dense Barbs (45SJ24, SAJH137059, Photo Courtesy Burke Museum).

shaft barb is not included in the assessment of shaft barb frequency, as it is generally wider than the space between individual shaft barbs.

Head and Shaft Microbarbs

Microbarbs are recorded as either present or absent for both the head and shaft.

Barb Paradigmatic Classification

The attributes discussed above were used to construct classes to be used in examining changes in barb morphology through time. Table 5.3 outlines the coding for these classes.

Table 5.3. Barb Paradigmatic Classification.

Character	States	Coding
Barb Shape	Straight or Convex, Squared	A, T
Barb Frequency	Dense, Isolated	G, C
Barb Ridges	Present, Absent	A, T
Barb Silhouette	Enclosed, Extended	G, C
Microbarbs	Present, Absent	A, T

Shaft barbs examined
Coding based on restrictions of ML approaches

Example class:
AGAGA- Straight or Convex, Dense Present, Enclosed, Present

Line Attachment Type

McMurdo (1972:34) in her analysis recognized eleven line attachment types. In addition to the line attachment types discussed by McMurdo, notched line attachments have been divided into incised and notched, line holes have been divided into drilled and gouged, and reverse barb line attachments have been added (Figure 5.18 shows line attachment types). Many of these types are not necessarily mutually exclusive. However, in the examined sample all line attachments fell under a single category.

Line Guard

A distinct protrusion below the shaft for the attachment of a retrieving line. May be bilateral or unilateral (McMurdo 1972:34).

Incised Line Guard

A unilateral or bilateral line attachment guide sawn into a line guard.

Notched Line Attachment

A unilateral or bilateral line attachment guide notched into the base of an artifact.

Shoulder

Shoulders are defined as a bilateral or unilateral protrusion for the attachment of a retrieving line which gradually taper into the base, as opposed to an abrupt cut. I disagree with McMurdo's (1972:34) definition that the tang of shouldered barbed points does not taper, as her definition ignores the morphological variation of this line attachment type .

Spool

These points have a circumferential line attachment, where material has been removed around the entire shaft (McMurdo 1972:34).

Constriction

Points with bases which have a slight unilateral or bilateral indentation that is not definite enough to be considered a notch (McMurdo 1972:34).

Drilled Line Hole

A hole drilled into the base of a point for the purposes of attaching a retrieving line (McMurdo 1972:34).

Gouged Line Hole

A line hole that is gouged or sawn into the base of a point for the purposes of attaching a retrieving line (McMurdo 1972:34).

Combination Line Hole

A line hole, either gouged or drilled, in combination with another form of line attachment such as a line guard or shoulder. These other forms of attachment may be bilateral or unilateral (McMurdo 1972:34).

Reverse Barb

This form of line attachment is when a barb, or barbs in the case of bilateral application, are present in lieu of other forms of line attachment. Such barbs are reversed, in order to secure a retrieving line. These are generally robust in construction and their alignment is reverse compared to the head and shaft barbs of the point.

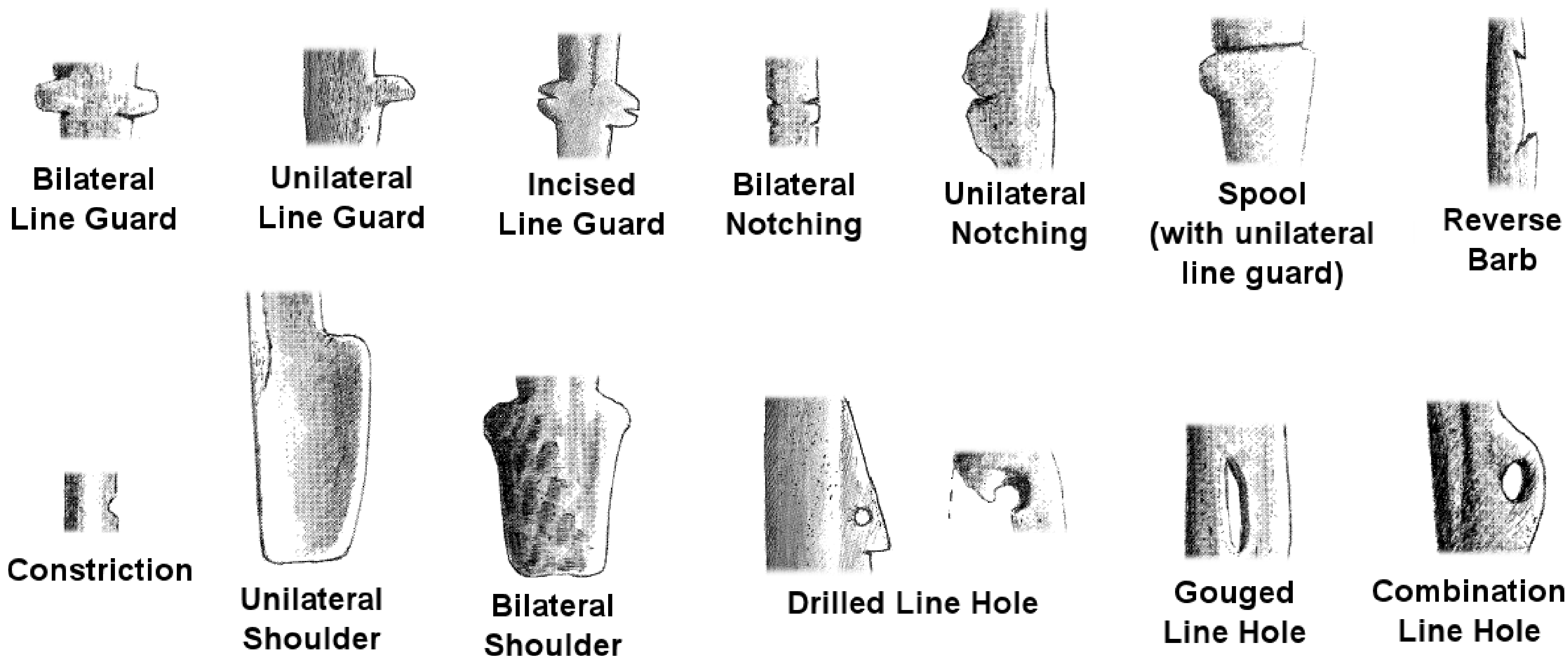


Figure 5.18. Line Attachment Types (Original Line Art Stewart 1973: 104-106).

Base Shape

McMurdo (1972:34) defines three types of bases: conical, wedged, and squared. Conical bases are pointed or rounded in nature, wedged bases are either thinned or have a wedge shape, and squared bases have a heavily squared off or rectangular base. These definitions were found to be insufficient for describing the morphological variation in barbed bone and antler point bases and were expanded and modified accordingly. Conical bases include only cone-shaped pointed bases, and are distinguished from rounded bases which lack such a point. Wedge-shaped bases have been redefined as being wedged in either plan view on one or both sides or wedged in profile view on both sides. Flanged bases, another new class constructed, are laterally asymmetrical on the side of barb application. The asymmetrical protrusion of a flanged base is rounded, although flanged bases appear flat and rectilinear from a plan view. Figure 5.19 demonstrates the variation in base types.

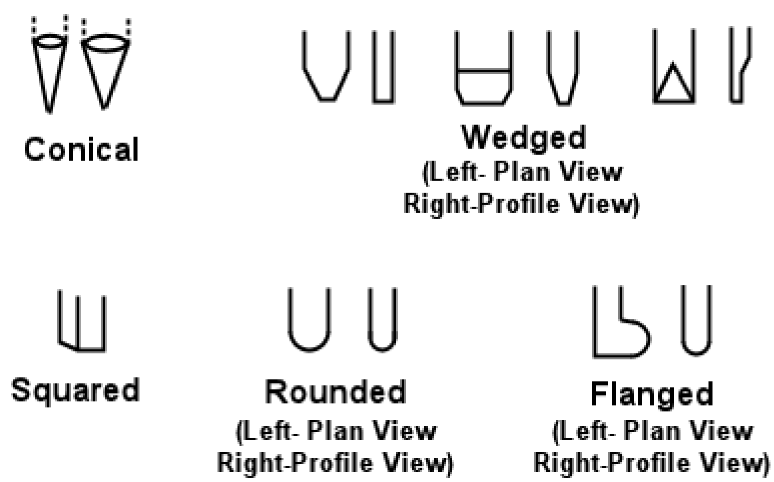


Figure 5.19. Base Shapes.

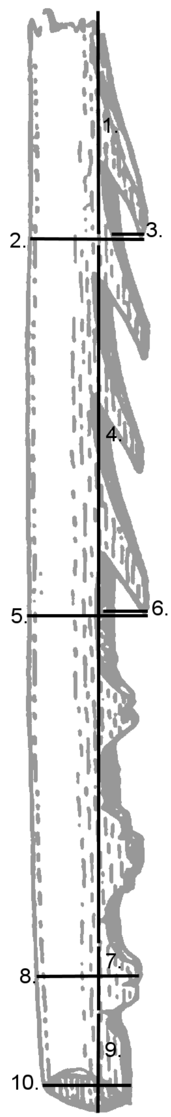
Base Asymmetry

Base asymmetry was recorded due to its functional importance in multiple fixed point systems. Barbed point base asymmetry primarily takes the form of lateral tapering on the side of the barb application on a unilateral point, enabling side-hafting (Figure 5.20). This character is reported as presence/absence.

Figure 5.20. Antler Point with Asymmetrical Base (45SJ280, Cat. #667, Photo Courtesy Burke Museum).

Metric Attributes

Metric attributes were measured in millimeters using calipers. All measurements were made using the calipers to form minimum containing rectangles. Figure 5.21 displays metric attributes on a fragmentary artifact lacking a head.



1. Head Length
2. Head Width
3. Maximum Head Barb Width
4. Shaft Length
5. Shaft Width
6. Maximum Shaft Barb Width
7. Line Attachment Length
8. Maximum Line Attachment Width
9. Base Length
10. Base Width

Figure 5.21. Barbed Point Metric Attributes (Line Art from Mason 1902: Plate 2).

Maximum Projectile Length, Width, and Thickness

Maximum Projectile Length was defined as the total length of the artifact from its proximal end to its distal end and the total width of the artifact. In situations where the length of the artifact was too long for a single caliper measure, barbs were used as landmarks for smaller minimum containing rectangles which were combined for the total length. Maximum Projectile Width was defined as either the distance between its most extended barbs or the width of the line attachment, and is in a plane perpendicular to projectile length. Maximum Projectile Thickness was the thickness of the artifact at its greatest point, and is in a plane perpendicular to both length and width.

Minimum Numbers of Barbs, Asymmetrical Barbs, and Microbarbs

These are counts of all barbs, asymmetrical barbs, and microbarbs on the artifact. Broken barbs were included in these counts.

Maximum Head, Shaft, Line Attachment, and Base Lengths

These are measures of the total length of each segment present on the artifact as defined under projectile segment definitions.

Maximum Head, Shaft, and Line Attachment Widths

These are measures of the total width of each segment, present as defined under projectile segment definitions.

Maximum Head and Shaft Barb Width

This is a measure of how far a barb laterally extends from the shaft. In order to maintain consistency in measurements, barb ridges were ignored. The shaft barb with the greatest extension was used for this measure.

Maximum Head and Shaft Barb Angles

Barb angle was measured to the nearest 5°, to ensure a balance between precision and accuracy, by placing the artifacts over a goniometer. The goniometer consisted of a flat piece of construction paper with a circle at its center demarcated with lines at 5° intervals. The barbed point was placed over the goniometer for measurement. A measurement of 0° is perpendicular to the axis of the shaft of the projectile while 90° is parallel. The shaft barb with the greatest angle was used for the barb angle measure.

Minimum Base Width

Minimum base width uses the thickness of the calipers as part of its minimum containing rectangle to determine the minimum width of the base.

Analytical Methods

The approach used in this analysis to investigate the cultural transmission of barbed points involved two stages. The first stage involved ensuring that the claodgrams were strong from a manufacturing standpoint. Selected characters had to be shared and derived in nature. In addition to this requirement, caused by functional morphological constraints, selected characters had to be stylistic according to Dunnell's (1978) definition, in order to not detect a 'false' phylogenetic signal caused by convergent evolution. In order to do this, barbed point variation was examined by functional class and 500 year BP time periods. The analytical methods discussed below were used to examine previous culture-historic hypotheses, and to determine stylistic characters for the cladistics analysis. Culture-historic trends in attributes were also investigated to inform the selection of an outgroup in the cladistics analysis.

Univariate and multivariate statistics were utilized to test whether or not the functional classes used were valid and if the trends in line attachment styles over time seen by Bennyhoff (1950) in northern Californian harpoons and McMurdo (1972) were present in this sample. Cross tabulations were used to investigate variation in characters according to functional class, and linear regressions were performed on metric attributes to detect relationships. Cross tabulations were used to examine changes in trait frequency over time, using 500 year BP periods. This enabled an examination of the temporal variation in traits McMurdo (1972:120-121) hypothesized as stylistic. Specifically, trends in line attachment types and traits relating to barb morphology were examined. Regression/Correlation and principle component analysis were utilized to determine which attributes were critical for understanding point variation. A scatter plot of the resulting principle components was used to examine whether or not there were significant metric differences between functional classes. SPSS 16 (SPSS, Inc. 2008) was used for the analysis of all descriptive statistics. For all descriptive statistical analyses, missing data was treated with case wise deletion.

Cluster Analysis

Cluster analysis was also utilized as an analytic method. According to King (2007:5), previous studies of bone points using cluster analysis (e.g. Ames 1976; Dewhirst 1980) have failed to produce meaningful artifact types. King argues this due to the considerable morphological variation and overlap in functional types exhibited by bone points in general. As opposed to constructing a typology, cluster analysis were utilized to test hypotheses regarding style and function. Specifically, attributes hypothesized to be stylistic or functional in nature were examined for changes in their geographic distribution between the Gulf of Georgia (0-1500 BP), Marpole (1500-2500 BP), and Locarno Beach (2500-3500) periods.

Jordan and Mace (2008) in their study of the cultural transmission of Coast Salish textile manufacturing methods suggest that in situations with a high degree of inter-group horizontal cultural transmission, cultural traditions would be transmitted around but not across the Gulf of Georgia. They suggest that the would gulf act as a barrier, and groups would tend for shorter range interactions. A direct comparison with Jordan and Mace's results was not possible as the sample of barbed points does not include materials from the regions of northeastern Vancouver Island they examined.

However, it was still possible to generate expectations from their analysis. Due to strong convergent evolution caused by directed guided variation, the pattern of cultural transmission detected by Jordan and Mace, where the Gulf acts as a barrier for transmission, was expected to appear in the cluster analysis of point functional characters. I predicted that functional characters would be similar throughout the Gulf of Georgia, resulting in clusters with members from a large geographic range. Stylistic attributes were expected to be more conservatively transmitted than textile manufacturing methods (detected as being horizontally transmitted in their study) due to prestige bias. This should result in a high degree of geographic localization in barbed point styles when prestige bias emerges as a social transmission factor around 2000 BP.

All cluster analyses were performed using Clustan Graphics 8.0 (Wishart 2006). Clustan was chosen due to its ability to handle mixed nominal, ordinal, interval-ratio, and binary data. The method use by Clustan to treat mixed data is discussed in depth by Wishart (2002). For each of these analyses, the data were standardized to Z-scores, using squared euclidean distance as the proximity measure. Using increases in the sum of squares, the data was then clustered hierarchically. All cases and variables were unweighted, and case-wise deletion was used on missing data. Clustan's cluster keys feature was used in each analysis to examine which characters determined clustering; that is, the characters which contributed the greatest amount of morphological variation in the sample.

Cladistics Analysis

The second stage of the analysis involved examining these characters using phylogenetic methods. PAUP*4.0 (Swofford 1998) was used for the cladistic analyses. All analyses were performed using paradigmatic classes constructed from morphological traits (e.g. Table 5.3). Paradigmatic classes have been utilized as one of the main means of constructing taxa in archaeological cladistics (e.g. Collard and Shennan 2000; O'Brien and Lyman 2000; Collard 2007; Croes 2003; Riede 2008). Derived, shared, stylistic characters were used as a basis for paradigmatic classes. All characters were coded as presence-absence data for compatibility with a maximum likelihood approach, originally developed to deal with nucleotide sequences (Felsenstein 2004:248). Analyses were performed using three scales of OTUs, individual artifacts as taxa, paradigmatic classes as taxa, and archaeological assemblages as taxa (data matrices are in Appendix B). The presence and absence of paradigmatic classes per site was used for characters in the analysis using archaeological sites as an OTU. Sites were selected as the OTU, instead of dated assemblages, in order to utilize as much examined material as possible in the analysis.

For the production of rooted cladograms, outgroups were selected from geographically outlying sites, ElSx1, FaSu2, FaSu10, and EaSu5. At the scale of artifacts as the OTU, all artifacts from these outlying sites were selected as the outgroup. For the analyses using paradigmatic classes as the OTU, the classes present in ElSx1, FaSu2, FaSu10, and EaSu5 were initially going to be selected as the outgroup. However, a significant number of classes present at these outlying sites were were also present in other assemblages. Due to this issue, the classes present in the 3500+ BP time period, the oldest sites examined, were used as the outgroup instead. In the analysis using sites as the OTU, ElSx1, FaSu2, FaSu10, and EaSu5 were selected as the outgroup.

Cladistics Optimality Criteria

In addition to running analyses using three types of OTUs, two forms of optimality criterion were utilized. The first is simple parsimony, directly comparable to the model developed by Eerkens and coauthors (2006). Higher CI values were expected at higher levels of OTUs, as the increased abstraction of artifact traits is expected to generate what would appear to be a stronger phylogenetic signal. Maximum likelihood was used as the second optimality criterion. Due to the fact that the number of possible trees that must be evaluated increases exponentially with the number of taxa (Felsenstein 2004:28), heuristic searches were necessary. As several equally parsimonious trees may result from a cladistics analysis, bootstrap 50% majority-rule consensus trees were constructed (Felsenstein 2004:342, 534).

VI. RESULTS

This chapter begins with a review of expectations for this analysis. Results are provided in three sections. The first describes the sample, and discusses component assignments. The second examines variation in barbed point types and traits. Barbed point variation is examined by functional class and time period. These analyses assessed previous claims regarding barbed point attributes, and examined whether point attributes are stylistic or functional. Results of the cluster analyses are provided, indicating whether or not localized styles emerge through time. Finally, the cladistics analyses are discussed with their implications for the social learning of barbed points.

Expectations

This section reviews hypotheses and expectations relating to barbed points, based on the ethnographic and archaeological literature in Chapters 2 and 5. These hypotheses are divided into predictions regarding functional and stylistic function (Table 6.1), chronological variation (Table 6.2), and cultural transmission (Table 6.3) discussed below. Expectations for the analyses investigating the cultural transmission of barbed points are also provided.

Table 6.1. Expectations for Functional and Stylistic Variation.

Question	Implications HA(H0)	Source
Are there manufacturing or functional constraints on attributes?	There are (not) distinct metric differences between functional classes as defined by Table 2.1.	
	Material use does (not) vary by functional class.	
	Barb morphology does (not) vary by functional class.	
	Head barb morphology will (not) demonstrate less morphological variation than shaft barb morphology due to functional constraints.	
Are there testable distinctions between functional subtypes of fixed points?	Fixed point profile does (not) correspond with base types.	Carlson (1954:24) argues that circular profile points correspond with conical bases (bird arrows). While lenticular profile points correspond with wedged bases (fish spears).
	Fixed point barb density does (not) correspond with projectile profile.	Clark (1975:129-130) hypothesizes that bird arrows have denser barbs than fish spears.
	Fixed point hafting size does (not) correspond with projectile profile.	Clark (1975:129-130) argues that fish spears have more hafting area than bird arrows.

Table 6.2. Expectations for Chronological Variation.

Question	Implications HA(H0)	Source
Do barbed point functions change through time?	The relative frequencies of functional classes, as defined in Table 2.1, (don't) vary by time period.	
	The use of antler as a material does (not) increase from 1500-2500 BP.	McMurdo (1972:119) detected an increase in the use of antler in barbed points dating from the Marpole period.
	There is (not) a transition to bilateral line attachment types during the Marpole period.	Marpole retrievable points have been argued to be diagnostic artifacts due to having bilateral line attachments. (e.g. McMurdo 1972:120-121, Burley 1980, Mitchell 1990)
	There is (not) a transition from bilateral to unilateral line attachments at the beginning of the Locarno Beach period, corresponding with a general trend in North American Pacific Coast barbed point morphology during this period.	Bennyhoff (1953) argues that there is a general transition before 3500 BP from bilateral to unilateral barbed points on the North American Pacific Coast.
Do barbed point individual identity markers emerge through time?	Barb morphology, excluding ridged barbs and microbarbs, does (not) vary by time period.	McMurdo (1972:119) observed that straight barbs were more common in the Marpole period and earlier, while squared barbs were characteristic of the late period (past 1000 years).
	Ridged barbs and microbarbs (do not) first appear after 2000 BP.	
	There is (not) a transition from notched to grooved microbarbs through time.	

Table 6.3. Expectations for Cultural Transmission.

Question	Implications HA(H0)	Test
Is cultural transmission conservative?	More localized styles will (not) emerge during the Gulf of Georgia phase as a result of an increased need for individual identity marks.	Cluster analysis of Gulf of Georgia phase stylistic attributes shows clusters consist of artifacts from assemblages with geographic proximity.
	Conservative forms of cultural transmission do (not) play a role in the social learning context of barbed points.	High consistency index values (>0.7) and likelihood scores (<-15) detected in cladistics analyses.
Is cultural transmission not conservative?	Different functional attributes will (not) be present throughout the Gulf of Georgia in all time periods examined due to shared functional constraints.	Cluster analysis of Gulf of Georgia phase stylistic attributes shows clusters consist of artifacts from assemblages throughout the region.
	Non-conservative forms of cultural transmission do (not) play a role in the social learning context of barbed points.	Low consistency index values (<0.5) and likelihood scores (<-30) detected in cladistics analysis.

Functional and Stylistic Variation

The validity of the functional classes (Table 2.1) used were tested using univariate and multivariate analyses. In the univariate analyses, metric attributes were explored to detect differences between functional classes. Regression/Correlation and Principle Component analysis were employed as multivariate analyses to examine the variation in barbed point metric attributes. Due to constraints of bone and antler as a material, covariation was predicted in most metric attributes. However, some attributes (maximum projectile width and maximum projectile length) were predicted to vary according to functional class. These attributes were expected to be detected in a scatter plot of principle components.

Material use was also predicted to vary by functional class, with antler being more commonly used for retrievable points than other classes. Barb morphology was not predicted to vary between functional classes, meaning that characters such as barb shape, extension, and density would be present in similar frequencies across all functional types. It was, however, expected that head barbs would demonstrate less morphological variation in metric attributes than shaft barbs. Head barbs, because they served as the arming element, should be subject to stronger functional constraints.

Finally, fixed points were examined in additional detail in order to assess hypotheses made by Carlson (1954:24) and Clark (1975:129-130). Carlson's inferences regarding point profile and base type, based on ethnographic analog, were predicted to be detected. Although Clark was discussing Maglemosian points, his hypotheses regarding barb density being tied to function as a 'bird arrow,' and 'fish spears' having longer bases due to increased hafting area, were predicted to be detected in this sample due to functional convergence.

Chronological Variation

While all barbed point types may be present in each time period, the relative proportions of these functional classes were predicted to vary. Barb morphology, excluding ridged barbs or microbarbs, was predicted to vary by time period. Extended straight barbs, such as those on the bilaterally barbed St. Mungo period points, were predicted to be more common in earlier time periods. Barb morphological variation was also predicted to increase through time, particularly after the Marpole period when inter-group interactions intensified, which potentially resulted in an increased need for identity markers. Ridged barbs and microbarbs were predicted to first appear after 2000 BP, due to this increased need for identity markers. A transition from notched to grooved microbarbs through time was also predicted, with grooved microbarbs appearing in the later periods. I suggest that Grooved microbarbs appear to have a more involved manufacturing process than notched microbarbs.

Changes in line attachment types and barb application through time were noted by both McMurdo (1972:119-120), in her examination of Northwest Coast barbed points, and Bennyhoff (1950), in his analysis of fish spears and harpoons from Northern California. The trends they discussed, such as billateral barb application being replaced with unilateral barb application in the Locarno Beach period, were expected to be detected in this sample.

Similarly, bilateral line attachment types were expected to be common in the Marpole period, but absent in the Locarno Beach period and later periods, fitting with McMurdo's observations. In addition, it was predicted that material use would change through time with antler being more commonly utilized during the Marpole period.

Cluster Analyses

Cluster analyses were employed to investigate changes in the stylistic and functional characters of barbed points between Gulf of Georgia cultural periods. Artifacts from site components dating to the Gulf of Georgia, Marpole, or Locarno Beach periods were included in separate cluster analyses. One set of cluster analyses examined characters hypothesized as stylistic, while a second examined characters hypothesized as functional. In total, six cluster analyses were run. The geographic boundaries of the resulting clusters were examined based on the presence and absence of a given assemblage in a cluster.

The clusters for functional characters were predicted to include sites from throughout the entire region in all periods due to shared artifact uses and functional constraints throughout the Gulf of Georgia. Stylistic character clusters for the Gulf of Georgia period were expected to consist of more widely dispersed components due to an increased need for personal identity markers on barbed points as inter-group interactions intensified with the emergence of the 'Developed Northwest Coast Pattern.'

Cladistics Analyses

For the purposes of this analysis, shaft barb morphological traits were considered evolutionarily informative, i.e. shared and derived traits. By definition, shaft barbs were shared characters, derived from hypothetical, ancestral, unbarbed points (e.g. Bennyhoff 1950: 259). Shaft barbs were considered as stylistic characters not influenced by directed guided variation.

A high consistency index value (CI >0.7) was predicted to be detected through the cladistics analysis, indicating prestige bias. High CI values were predicted to be found in all cladograms regardless of the operational taxonomic unit (OTU) used. Low CI values (<0.5) would indicate a stochastic pattern of cultural transmission, caused by inter-group horizontal transmission, intra-group horizontal transmission, or undirected guided variation.

Although the results of the maximum likelihood analyses were not directly comparable, numerically higher likelihood scores (<-15) were interpreted as indicating prestige bias. Similar to the maximum parsimony cladograms, it was predicted that as the scale of OTU increases so would the likelihood score. Low likelihood scores (<-30) indicated the presence of undirected guided variation as the cultural evolutionary force acting on these characters.

The Sample

The sample discussed here consists of 593 barbed bone and antler points from 56 archaeological sites located in the Gulf of Georgia region (Figure 1.1). Artifacts were from the collections at Western Washington University, the Burke Museum, the Royal British Columbia Museum, and Simon Fraser University. Chronologically, the sample spans from 5500 BP to contact. However, the majority of artifacts date from the Marpole and Gulf of Georgia periods, dating from 0-2500 BP. Provenience information was recorded for all artifacts when available (Appendix D). Provenience data was used to associate artifacts with site components.

Overlap with Past Analyses

This sample re-analyzes some materials from McMurdo's (1972) thesis. McMurdo's geographic scope included the central and southern Northwest Coast (by Ames and Maschner's 1994 definition), but focused primarily upon the Gulf Islands and Fraser region. This thesis has a similar geographic focus, although collections with sites from the Fraser region were not examined as discussed in the previous chapter. My analysis examined five sites that McMurdo analyzed (DcRt15, DgRw4 False Narrows, DcRv1, and ElSx1 Namu). Fragmentary artifacts from these sites not examined by McMurdo are included. Hoover (1971) analyzed tanged antler points from DgRw4 False Narrows, which I also examined. Although I do not use Hoover's typology, my findings were consistent with his interpretations. The barbed points from several of the sites examined have been measured and illustrated in reports and publications (e.g. Grabert et al. 1978 for 45WH17; Kenny 1974 for DcRt10; Mitchell 1979 for DcRt13; Mitchell 1981 for DcRu78; IR Wilson Consultants

2005 for DdRt6; Burley 1989 for DgRw4). Point metric data from these sources is compared with my data in Appendix C. Artifacts confirmed to have been previously analyzed constituted a small portion of the sample (N=46).

Chronological Assignments

Site components were assigned 500 year BP time periods (Table 6.4), based on mean conventional ^{14}C dates associated with each analytic unit. Sites lacking conventional radiocarbon dates were assigned to time periods based on the midpoint of their age estimate. Age estimates were used only if barbed bone and antler projectiles were not the sole diagnostic artifact. Sites without age estimates and provenience information were

Table 6.4. 500 year BP Time Period Designations and Age Ranges in Years BP.

Designation	Range
500	0-500
1000	500-100
1500	1000-1500
2000	1500-2000
2500	2000-2500
3000	2500-3000
3500	3000-3500
4500	4000-4500
6000	5500-6000

omitted from analyses with a chronological component. McMurdo's (1972) age estimates for barbed points included in her analysis were not used in assigning ages to components, instead the literature for each site was consulted in order to establish point ages. Table 6.5 lists sites the age estimates or conventional ^{14}C dates of assigned components, and sources which discuss the chronological contexts of the sites. Appendix D includes the sites and associated time periods for each artifact. Out of the 593 artifacts examined, 513 had sufficient contextual information to be assigned a 500 year BP period. The majority of the sample dates from contact to 2000 BP. The total sample size of artifacts from time periods before 2000 BP is 69 artifacts.

Table 6.5. Mean Conventional ^{14}C Dates and Age Estimates of Examined Assemblages.

Site	Analytic Units	C14 Dated	N	Period	Min Age	Max Age	Mean Age	Sources	Notes
45IS31b		Yes	1	500	385	695	540	Bryan 1963, Smith 2001	
45SJ1		Yes	8	2000	1190	2540	1845	Stein 2000, Stein, et al. 2003, King 1950, Carlson 1960	
45SJ24	Operation A	Yes	19	1000	390	1750	802	Deo, et al. 2004, Stein, et al. 2003, Stein 2000	
45SJ24	Operation D	Yes	21	1500	760	2050	1456	" "	
45SJ25		Yes	1	1500	1500	1620	1560	Carlson 1960, Thompson 1978	
45SJ105		Yes	11	1000	310	2050	1064	Kidd 1964, Kidd 1969, Stein, et al. 2003	
45SJ185		No		2000	1500	2500	1750	Stein 2000, Forbes 1949, Carlson 1960	
45SJ186		No		1000	0	1300	650	Carlson 1960	
45SJ280		Yes	8	2000	70	2680	1779	Deo, et al. 2004, Stein, et al. 2003	
45SK7		Yes	2	500	110	700	405	Bryan 1963, Robinson and Thompson 1981	
45SK37		Yes	4	500	280	755	498	Kidd 1964, Thompson 1978	
45SK59a		Yes	3	1000	730	1310	1017	Thompson 1978	
45SK81		No						" "	Surface Collection, No Provenience
Thompson Survey		No						" "	Surface Collection, No Provenience
45IS7		Yes	3	1500	970	1420	1157	Kopperl 2006	
45SK46		Yes	3	3500	3170	3510	3333	Mather 2009	
45WH1	NW Structure	Yes	1	3500	3310	3370	3340	Blodgett 1976, Grabert 1988, Markham 1993, Dugas 1996	
45WH1	Eastern Units	Yes	4	2000	1440	2870	2203	" "	
45WH9		Yes	3	2000	740	3215	1753	Grabert, et al. 1976, Larsen 1971, Montgomery, et al. 1977, Gaston, et al. 1975	
45WH11		Yes	2	2000	1380	2043	1723	Larsen 1971	
45WH17	Semiahmoo Spit, Early	Yes	2	3000	2300	2895	2600	Grabert, et al. 1978, Montgomery 1979	
45WH17	Semiahmoo Spit, Late	Yes	3	1000	300	890	587	" "	
45WH29		No							
45WH34		Yes	10	4500	3960	5050	4482	Gillis 2007, Hutchings 2004	
DcRt9		Yes	1	2000	1650	1870	1760	Keddie 2008	
DcRt10	Zone A	Yes	2	500	205	695	450	Keddie 2008, Kenny 1974, Keddie 1992	
DcRt10	Zone B	Yes	4	2500	1510	2720	2220	" "	

Site	Analytic Units	C14 Dated	N	Period	Min Age	Max Age	Mean Age	Sources	Notes
DcRt13		Yes	3	3000	2430	2510	2648	Keddie 2008, Mitchell 1971, Mitchell 1979	
DcRt15	Cadboro Bay I	Yes	1	2000	1720	1900	1810	McMurdo 1972, Keddie 2008	
DcRt15	Cadboro Bay II	No		500	0	500	250	" "	
DcRt16		No		500	0	500	250	Personal Communication Keddie 2008	
DcRty		No						Personal Communication Keddie 2008	Surface Collection, No Provenience
DcRu2		Yes	2	1000	140	1440	770	McMurdo 1972, Spurling 1976	
DcRu4		No						Keddie 2008	
DcRu7		Yes	1	1000	950	1090	1020	Personal Communication Keddie 2008	
DcRu12	Zone A	Yes	3	500	100	940	547	Keddie 2008, Keddie 1987	
DcRu12	Zone B	Yes	1	1500	1240	1380	1310	" "	
DcRu12	Zone C	Yes	2	2500	1985	2870	2428	" "	
DcRu78		No		1500	200	1500	850	Mitchell 1981	
DcRv1	Pedder Bay II	Yes	1	2000	1480	1680	1580	McMurdo 1971, Keddie 2008, Mitchell 1971	
DcRwy		No						Personal Communication Keddie 2008	Surface Collection, No Provenience
DdRt6		No		500	0	500	250	I.R. Wilson Consultants 2005	
DdRu1		No		2000	2000	2000	2000	Personal Communication Keddie 2008	
DdRu4		No		1000	600	900	750	Personal Communication Keddie 2008	
DdRu8		No							
DdRu12		No							
DdRuy		No						Personal Communication Keddie 2008	Surface Collection, No Provenience
DdRvy		No						Personal Communication Keddie 2008	Surface Collection, No Provenience
DeRty		No						Personal Communication Keddie 2008	Surface Collection, No Provenience
DeRu1	Locarno Beach Deposit	Yes	3	3500	1770	3930	3188	Dady, P. 2002.	
DeRu15		No							
DeRv107		Yes	3	1000	230	1190	1017	Yip 1981, Eldridge 1988, Hanson 1991	

Site	Analytic Units	C14 Dated	N	Period	Min Age	Max Age	Mean Age	Sources	Notes
DeRvy		No						Personal Communication Keddie 2008	Surface Collection, No Provenience
DgRw4	False Narrows III, IV	No		500	0	650	325	McMurdo 1971, Mitchell 1971, Burley 1989	
DgRw4	False Narrows I, II	Yes	2	2000	1590	1760	1690	" "	
DhRx6		No		2000	1000	2800	1900	Personal Communication Keddie 2008	
DhRx16		Yes	5	2500	1330	2920	2426	Keddie 2008	
EaSu5		No							
DeRt2	NW Mound Midden	Yes	3	5000	4260	5390	4727	McMurdo 1969, Carlson et al. 1993	
DeRt2	Main Deposit	Yes	18	3500	2400	4540	3558	" "	
DeRt2	Late Midden	Yes	6	1500	795	2320	1392	" "	
DeRt1	SU2b, SU3	Yes	4	3000	2370	3010	2585	McMurdo 1969, Carlson et al. 1993, Hanson 1991	
DeRt1	SU4, SU5a, SU5b	Yes	7	2000	1280	2560	1984	" "	
DeRt1	SU6	Yes	4	500	160	760	465	" "	
FaSu10		Yes	1	2000	1670	1850	1760	Pomeroy 1980	
FaSu2	Kwatna II	Yes	2	500	0	420	180	McMurdo 1971, Carlson 1972	
FaSu2	Kwatna I	Yes	2	1500	590	1570	1070	" "	
DfRu8	Helen Pt II	Yes	4	1500	1010	2215	1425	McMurdo 1974, Carlson 1970, Carlson 1972	
ElSx1	Period 2	Yes	7	6000	5080	6160	5584	McMurdo 1971, Carlson 1991a	
ElSx1	Period 3	Yes	2	5000	4400	4905	4674	" "	
ElSx1	Period 4	Yes	3	4500	3720	4550	4201	" "	
ElSx1	Period 5	Yes	10	3000	2100	3940	3020	" "	
ElSx1	Period 6	Yes	7	1500	400	1970	1248	" "	

N=Number of C14 Dates

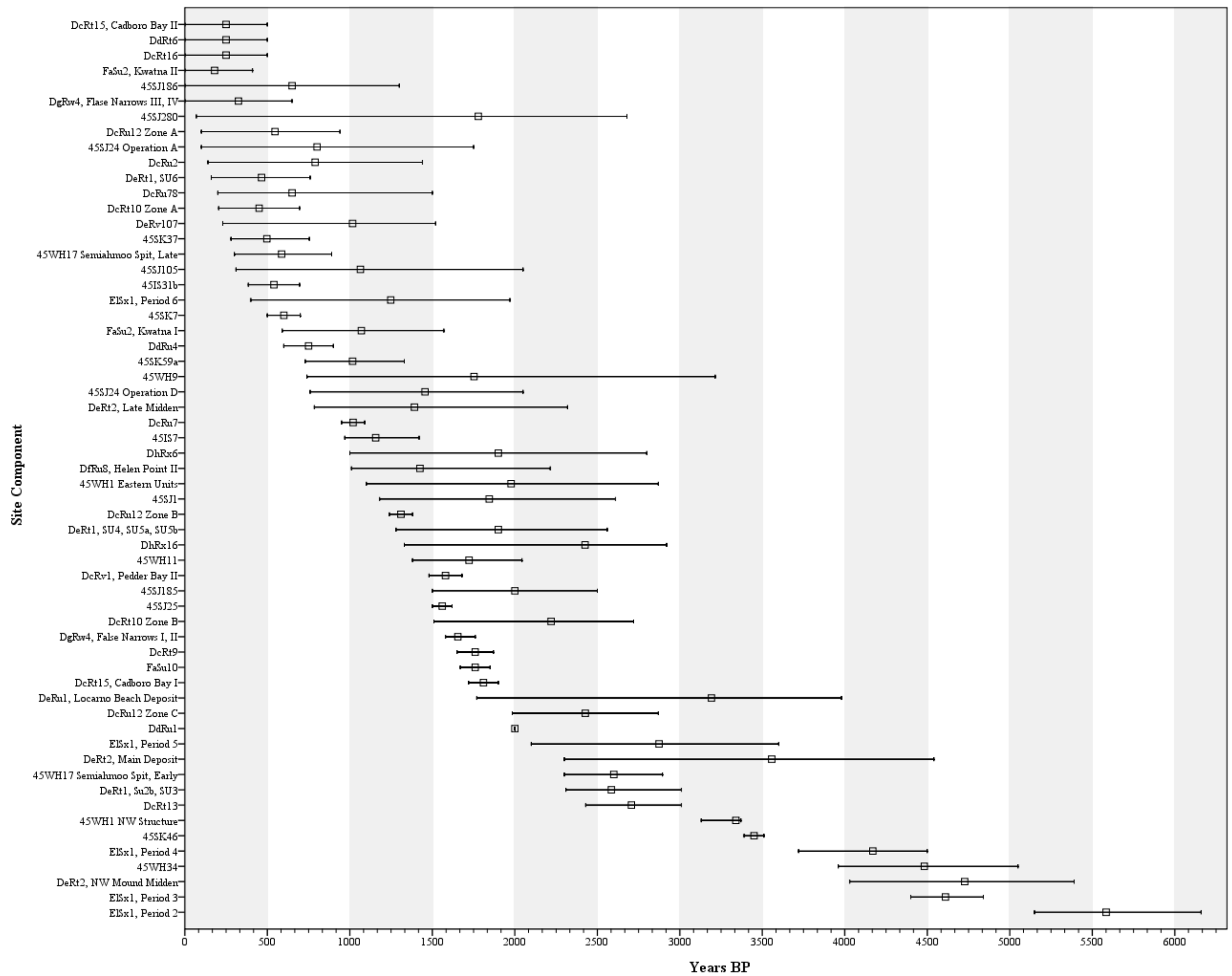


Figure 6.1. Radiocarbon Date and Age Estimate Ranges for Dated Sites and Components (Arranged by Minimum Age, Mean Age Indicated by Box).

Component Assignments

The analytical units for DcRt10, DcRt15, DcRu12, DcRv1, DeRu1, DgRw4, DeRt2. DeRt1, FaSu2, DfRu8, and ElSx1 are based on site components in the sources cited in Table 6.4. Artifacts which could not be associated with these components were excluded from elements of this analysis with a chronological component. Other sites consisting of multiple analytical units, and the justification used for these units, are discussed below. The locations of all sites discussed are provided in Figure 1.1.

45SJ24

English Camp (45SJ24) on San Juan Island has been divided into two analytical units based on the excavation operations. Operation D, located in a wooded area to the northwest of the historic British parade grounds is the older occupation dating from the late Marpole period to early San Juan period (Stein 2000; Stein et al. 2003). Operation A, located in the parade grounds, was a San Juan period occupation dating from 1000 BP to the historic period. The accumulation rates of the two areas differ, as Operation D formed in a time frame of a few hundred years, while the midden at Operation A formed gradually over 1,000 years. Each operation represents a distinct occupation of the site, and are treated as analytical units for this analysis.

45WH9

Birch Bay (45WH9) contained three worked bone artifacts (Catalog #s 122, 209, 312) considered by Grabert to be barbed bone points (Grabert et al. 1976). Two (Catalog #s 122 and 312) were included in this analysis. Artifact #209, which Grabert considered as a leister barb lacks the asymmetrical base or curved profile used to define a barbed point as a leister. What appears to be a fragmentary barb is present on this artifact in a reverse position, and it appears to have a wedged shaped base with a notch on its proximal end. This artifact was measured, but was omitted from this analysis as it is fragmentary and difficult to assess if this artifact is indeed a barbed point. Three ^{14}C dates for 45WH9 spanning roughly 2500 years from about 750-3200 BP. One of these dates was located in the same excavation unit, Test Cut A, as one of the analyzed barbed points. This was a date of 848±108 BP at a depth of 165cm BS (Larsen 1971, Gaston et al. 1975). The barbed point (Artifact #122) was located at a depth of 22cm BS, well above this radiocarbon date. This barbed point was assigned to the 500-1000 BP time period based on the ^{14}C date in this unit, although the point may be even younger than this radiocarbon date. The second barbed point from this site (Artifact #312), located in Test Cut D at a depth of 49cm BS was assigned to the 1500-2000 BP time period based on the mean age of all radiocarbon dates from 45WH9.

45WH17

Semiahmoo Spit (45WH17) is a complex shell midden with Locarno Beach and Gulf of Georgia period occupations (Grabert et. al 1978). Barbed points were assigned to two components based on an examination of radiocarbon dates, their depths, and horizontal locations (but not based on a full stratigraphic analysis of the site). The earlier component is located on the eastern higher portion of the site where four radiocarbon dates ranging from approximately 2470-4700 BP were obtained at depths varying from 150-325cm BS. In contrast, the lower area towards the water appears to have consistently younger deposits. The three radiocarbon dates from this area range from approximately 350-830 BP and were found at depths greater than one meter (Table 6.6). Only two barbed points were found in the upper, earlier, area and it was possible to narrow the age estimate for these points (Table 6.7). One point (Artifact #730) was located in S30 E5 between 70-80cm BS. Unit S28E9, approximately ten meters away has two radiocarbon dates, the first (2370±70 BP) was from a depth 150-170cm BS while the second (2830±65 BP) was at a depth of 295cm BS. Although there are two earlier ^{14}C dates in this area, I use these two dates as the maximum possible age for the point.

The second point from this earlier component (Artifact #1105) was located in S18E7, at a depth of 60-70cm BS in the same unit. An early ^{14}C of 2715±55 BP was obtained at a depth of 190cm BS. Due to the 130cm vertical difference, this earlier ^{14}C date was not used as a bracketing date for this artifact. Instead, the same maximum bracketing dates used for the first artifact discussed (Artifact #730) were applied. Both points were assigned to the 2500-3000 BP time period.

None of the 11 barbed points in the lower units were found at a depth greater than 60cm (Table 6.7). Extrapolating across this region, it appears that the upper 100cm of the deposit is less than 1000 years old. Given that all barbed points were found in the upper meter of this area, the mean age of all ^{14}C dates from this area (587 BP) was used for the component assignment. This is a conservative assignment, and it is possible to further narrow the age estimates of some points, although this was not done. For example, S40W17 contains a ^{14}C date of 350 BP at a 100cm and two barbed points were recovered from depths less than 90cm. To summarize the component assignments at 45WH17; two artifacts were assigned to the older component, which has a mean ^{14}C age of 2600 BP. All other barbed points from Semiahmoo spit have been assigned to the later component which has a mean ^{14}C age of 587 BP and falls under the 500-1000 BP time period.

Table 6.6. Radiocarbon Dates, 45WH17.

Sample ID #	Catalog or Level Bag Data	Cut	Level (cm BS)	Conventional C14 Date (Years BP)	Material	Source
Unknown	Cat. #1302	S40 W17	100	350±50	Charcoal	Montgomery 1979
" "	Cat. #1568	S6 W4	100-110	580±60	Charcoal	" "
" "	Cat. #840	S17 W5	170	830±60	Charcoal	" "
" "	Cat. #811	S19 E12	150-170	2370±70	Charcoal	" "
" "	Cat. #s 1569, 1577	S18 E7	190-210	2715±55[1]	Charcoal	" "
" "	Cat. #1076	S28 E9	295-300	2830±65	Charcoal	" "
" "	Cat. #1215	S28 E9	320-325	3015±65	Charcoal	" "

[1]Erroneously reported as 4715±55 in hard copy version of this thesis

Table 6.7. Barbed Point Proveniences, 45WH17.

Artifact #	Cut	Level (cm BS)
13	S1 E2	0-20
62	S1 E2	0-20
177	N1 E3	20-40
485	S17 W5	10 20
730	S30 E5	70-80
1105	S18 E7	60-70
1142	S28 W10	30-40
1170	S40 W17	10 20
1173	S35 W14	50-60
1180	S15 W14	50-60
1181	S35 W14	50-60
1275	S35 W14	50-60
1496	S40 W17	90-100

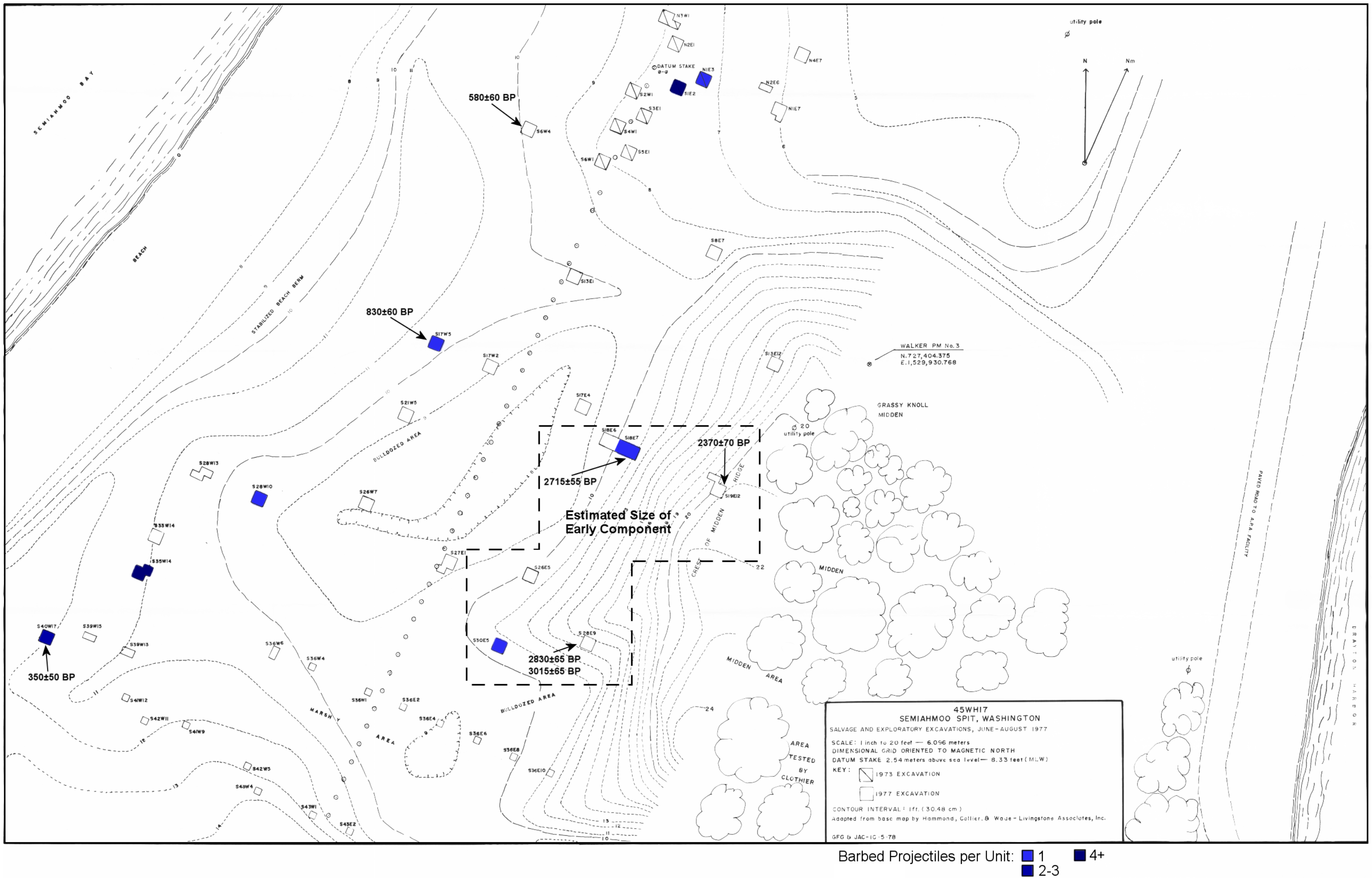


Figure 6.2. Semiahmoo Spit (45WH17) Analytic Units, Barbed Bone and Antler Projectile Counts, and Radiocarbon Dates (Base map adapted from Montgomery 1979:53).

45WH34

The main occupation of the Ferndale site dates to the St. Mungo or Charles period, based on 12 radiocarbon dates with means ranging from 4400-4800 BP (Gillis 2007). This assemblage contained six barbed points, five of which (Cat. #s 235, 359, 203\208, 287, 359b) were readily assigned to the St. Mungo component. One point (Cat. #505), however, was from a unit (S1W7) that had also yielded three radiocarbon dates postdating the St. Mungo period (mean ^{14}C age 776 BP). Meidinger (2008) argues that these dates are from intrusive materials. The single barbed bone point in S1W7, was from the southeast corner of the unit at a depth of 80-100cm BS. An aggregate shell sample from S1W7 at a depth of 20-40cm BD yielded a date of 4890±70 BP, while the aforementioned intrusive dates range in depth from 30-100cm BD. The horizontal extent of this intrusion is not well defined in feature descriptions. However, all the intrusive dates were from wood and charcoal samples located in the western half of the unit. For this analysis, the barbed point is considered as outside the boundaries of this intrusion and is associated with the earlier St. Mungo period component of the site.

45WH1 Site Context and Component Assignments

Cherry Point (45WH1) was initially excavated by Herbert Taylor in 1954 and 1956, followed by six field school seasons over 17 years (excavations in 1969, 1970, 1971, 1975, 1976, and 1986) by Garland Grabert (Markham 1993). An extensive shell midden site situated on a wave cut bank, Cherry Point overlooks the Strait of Georgia (Figure 6.3) at Cherry Point in western Whatcom County, Washington, 14 miles north of Bellingham. Radiocarbon dates taken by Grabert place the occupation of the site between 1300-2400 BP (Grabert 1988). The presence of diagnostic Marpole and Locarno Beach period artifacts corresponds with these radiocarbon dates (Grabert 1988, Carlson 1983).

Because there is a significant sample of barbed points (N=41) from Cherry Point, for this thesis I acquired two additional radiocarbon dates in order to better determine the relative ages of the barbed bone and antler points from this assemblage. Two excavation areas of the site with significant concentrations of points, the northwest and southeast blocks, lacked radiocarbon dates. Thirteen barbed points were located in the northwest block while twelve were present in the southeast (Figure 6.3).

No new dates were acquired for the southeast block. This portion of the site was dated based on interment style and previous radiocarbon dates. Three excavation units (S21E24, S23E27, and S23E29) uncovered human burials excavated into a clay deposit extending from 90-150cm BD. The cairn and grave pit styles are diagnostic of the Marpole period according to Grabert (1988). The closest radiometric date to the southeast block was 35 meters northwest of S24E29 from S9E19 50-60cm BD. This charcoal sample dated at 1640±200 BP, the late Marpole period. Despite this significant horizontal distance, these barbed bone points appear to date from either the late Marpole or early Gulf of Georgia period and will be treated accordingly in this analysis.

The nearest previously available radiocarbon date to the northwest block excavation was from a charcoal sample from S3W4 at 70-80cm BS, approximately fifteen meters southeast from S1W10 and four meters east of the southeast corner of the temporary structure (Table 6.8). As horizontally separated radiocarbon dates in shell middens may vary significantly (e.g. Stein et al. 2003), the Marpole period date of 1300±200 BP does not necessarily indicate the age of the structures indicated by Grabert. Two new ^{14}C dates were acquired to date the barbed points located in the northwest excavation block.

The first ^{14}C date was made on a marine shell sample consisting of *Thais lamellosa* from cut S1W10 at 60-80cm below surface was chosen to represent the northwest block excavation. This sample was located in the strata of an intrusive fire pit feature in the southern portion of the cut (Figure 6.4, S1W10 south wall profile adapted from originals). According to Grabert (1988), this fire pit feature was part of a large fish drying rack associated with a temporary summer structure. The shell sample was sent to the University of Georgia Center for Isotope Studies. The accelerator mass spectrometry (AMS) radiocarbon date had a conventional ^{14}C age of 1470±25 BP (UGAMS03342, marine shell, $\delta^{13}C = 1.8$), and a calibrated age of 1270-1388 cal AD. It was calibrated at 2σ with the program CALIB 5.01 (Stuiver et al. 2005) using the Marine04 radiocarbon age calibration (Hughen et al. 2004) and the Deo and coauthors (2004) local marine reservoir correction.

A second radiocarbon date was made on an aggregate shell sample from S1W10 80-100cm BS, the stratum below the previous date. This sample was also comprised of *Thais* *lamellosa*. It yielded a conventional ^{14}C age of 3340±30 BP (UGAMS04047, marine shell, $\delta^{13}C = 0.9$), dating to the Locarno Beach period. Unfortunately due to the lack of point proveniences for these artifacts, clearly associating them with specific stratigraphic layers in the 60-80cm BS level was not possible and so the actual stratigraphic association of these points remains unknown. However, the Locarno Beach period radiocarbon date has been used for the chronological assignment of the NW excavation block, as the barbed points from other NW block units appear to be situated in the strata which yielded the Locarno Beach ^{14}C date.

Table 6.8. Radiocarbon Dates, 45WH1.

Sample ID #	Catalog or Level Bag Data	Cut	Level (cm BS)[1]	Conventional C14 Date (Years BP)	Material	Source
RL272	Cat. #1597	S7 E8	160-175	2630±240	Charcoal	Blodgett 1975[2]
None[5]	Cat. #633	S1 E1	60-80	2340±200	Charcoal	" "
" "	Cat. #1149	S3 W4	70-80 (72)	1300±200	Charcoal	" "
" "	Cat. #1250	S9 E19	50-60 (59)	1640±200	Charcoal	" "
" "	Cat. #1561	S8 E8	140-160	960±200[3]	Charcoal	" "
UGAMS03342	Level bag	S1 W10	60-80	1470±25[4]	Marine shell	
UGAMS04047	Level bag, aggregate sample	S1 W10	80-100	3340±30[4]	Marine shell	

[1]Actual depth in parenthesis
[2]Grabert's C14 dates recorded in Blodgett
[3]Does not correlate with other dates according to Grabert and Blodgett
[4]$\delta^{13}C$ corrected
[5]Western Washington State College Geology Department, No Lab Number

Table 6.9. Barbed Point Proveniences, 45WH1.

Artifact #	Cut	Level (cm BS)	Artifact #	Cut	Level (cm BS)
55	S1 W8	20-40	2469	S15 E15	0-20
66	S1 W8	40-60	2528	S16 E17	60-80
82	S1 W8	0-10	2577	S24 E27	20-80 (79)
168	S1 W9	60-80	2633	S15 E15	40-60
244	S3 W8	0-20	2648	S8 E9	60-80
510	S7 E6	20-40	2999	S24 E29	20-40
532	S5 W4	20-40	3002	S24 E29	20-40
583	S7 E6	40-60	3076	S287 E29	60-80
665	S2 W10	20-40	3086	S21 E29	20-40
680	S2 W10	20-40	3132	S20 E29	20-40
707	S2 W10	20-40	3218	S23 E29	30-60
722	S2 W10	40-60	3277	S22 E29	80-100
783	S2 W10	40-60	4518	S21 E29	40-60
854	S1 E6	0-20	4565	S2 W9	
947	S6 E11	40-60	4582	Trench Cut 2	54-64
982	N3 W4	40-60	1708, 1720	Trench 2, N	6-12"
1196	S20 E27	40-60	2687, 2712	S16 E17	100-120
1451	S6 E9	50-70	730, 618, 669	S2 W10	40-60
2073	S22 E27	0-20	884, 746, 885, 886	S1 W10	60-80
2216	S16 E17	20-40			
2270	S22 E27	20-40			
2406	S22 E27	80-100			

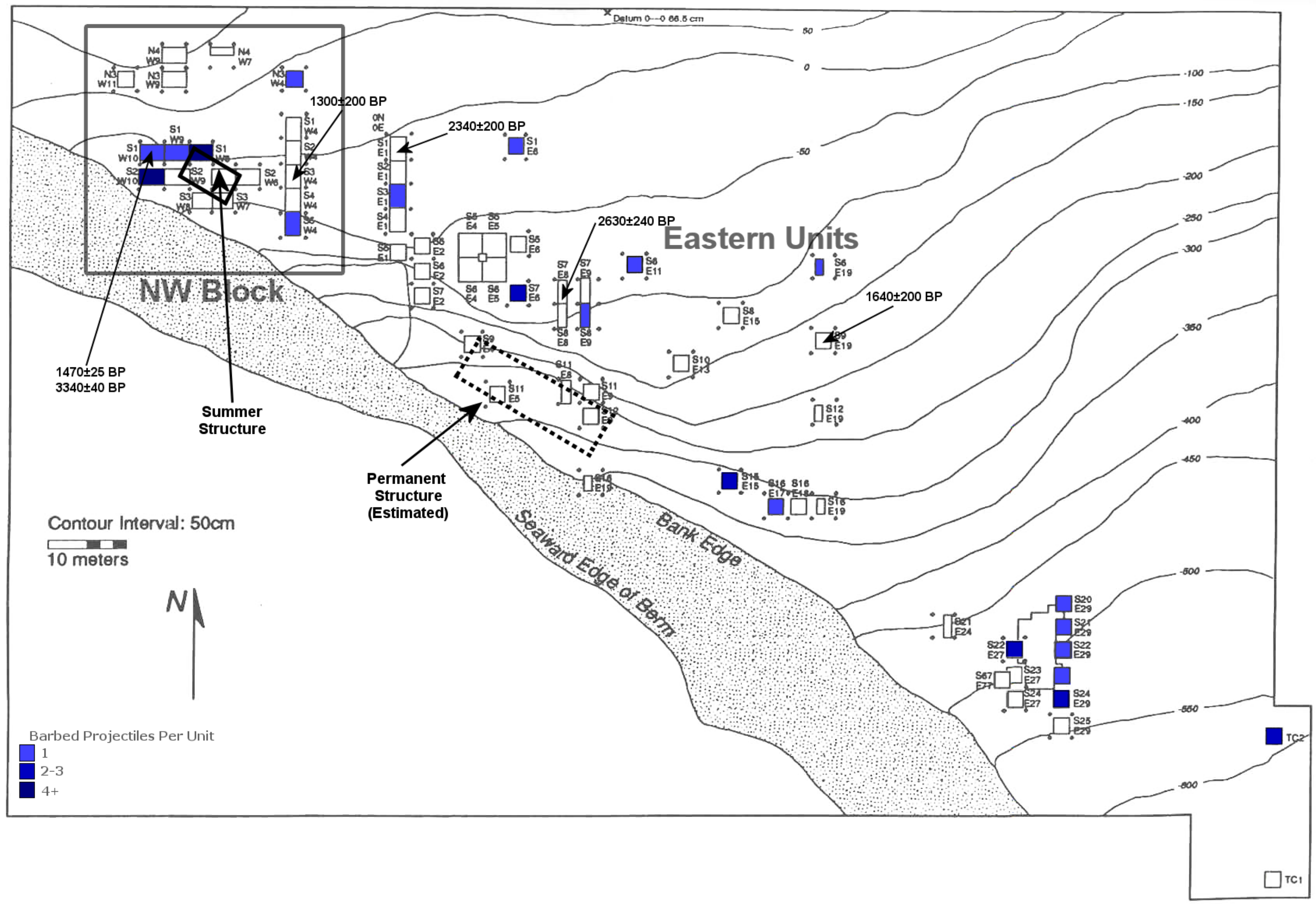
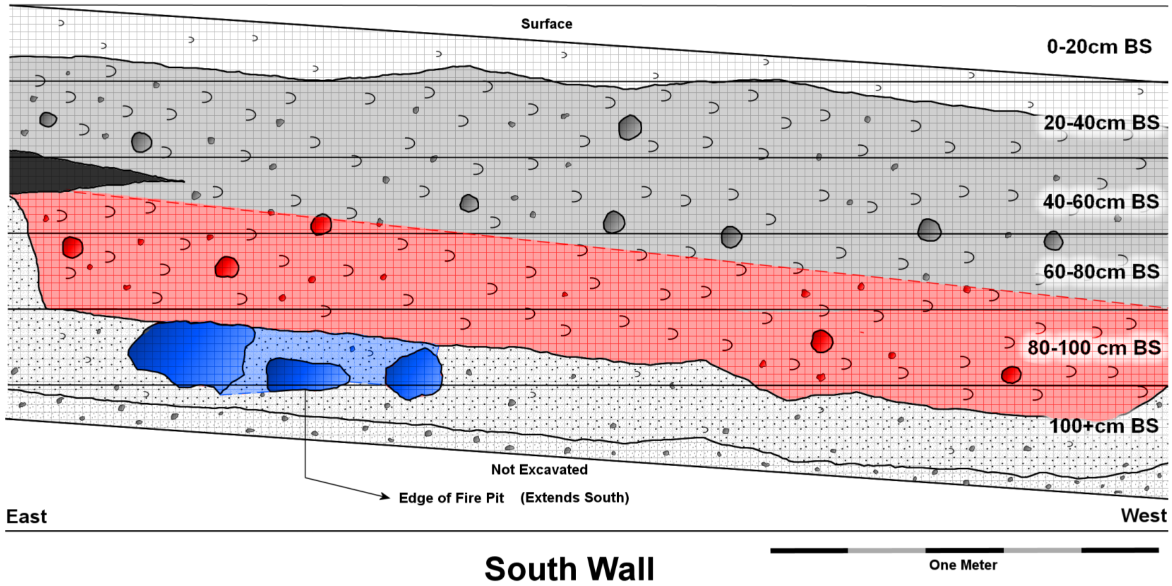


Figure 6.3. Cherry Point (45WH1) Analytic Units, Barbed Bone and Antler Projectile Counts, and Radiocarbon Dates (Base map adapted from Blodgett 1976: 117 and Markham 1993: 14).



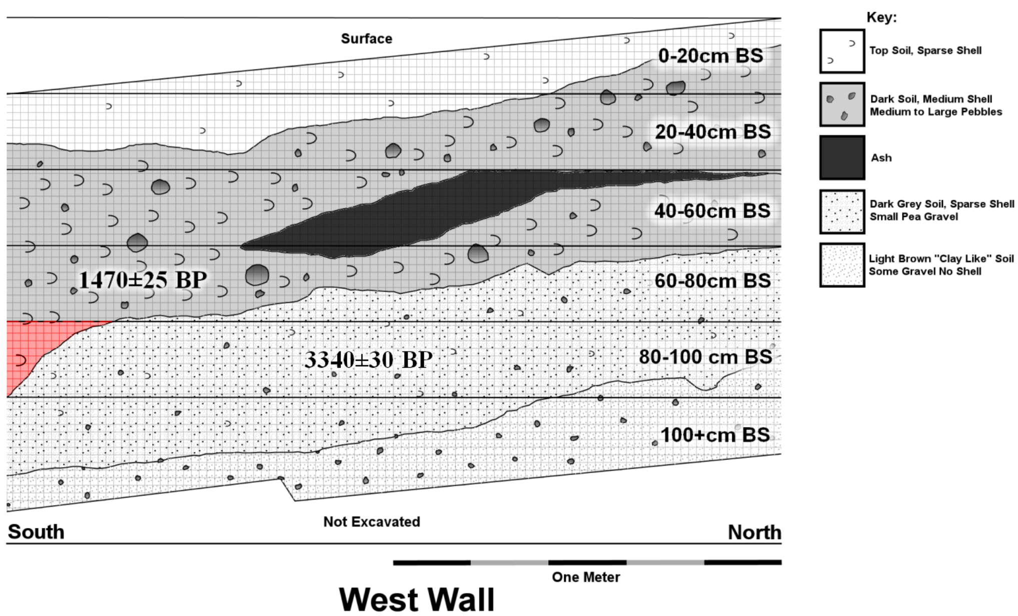


Figure 6.4. Unit Profiles, 45WH1 S1W10 (Depth Below Surface Based on NW Corner).

The southern portion of this unit contains two distinct features. The first, marked in blue, is a fire pit noted in the field notes. The second feature, marked in red, may be an expansion and re-use of the older fire pit. A ^{14}C date (UGAMS03342, 1470±25 BP) was taken from a shell sample from the southern portion of the 60-80cm level, which consists of material from the upper stratum of denser midden extending south into unit S2W10. A second ^{14}C date (UGAMS04047, 3340±30 BP) was obtained on an aggregate shell sample from 80-100cm BS from the lower, sparser, midden deposit.

Sample Attributes and Biases

A total of 593 artifacts were examined, 513 of which were given chronological assignments. Approximately 219 artifacts date from the Gulf of Georgia period (0-1500 BP), and 251 to the Marpole period (1500-2500 BP). Only 15 artifacts dated to the Locarno Beach period (2500-3000 BP), while 28 artifacts dated from the St. Mungo period or earlier (3500 BP+). A breakdown of artifact counts by time period has been provided in Figure 6.5. The sample is strongly biased towards the late period.

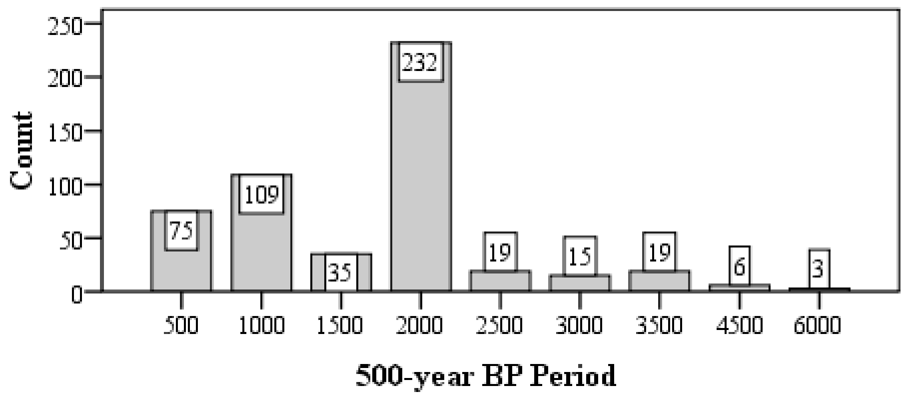


Figure 6.5. Sample Size by 500 year BP Period (N=513).

General attributes of barbed points examined included artifact completeness, fire modification, and material type. The sample included 111 complete artifacts; 90 were from dated contexts. Shaft fragments of barbed bone and antler points formed the majority of the sample (N=157), followed by fragments consisting of the head and shaft (N=129). These fragments were not assigned to functional classes, unless shaft curvature was present, in which case the artifact was designated as a leister. Approximately half of all examined artifacts (N=291) were complete enough to be assigned functional classes.

Table 6.10 displays the frequencies of complete and incomplete barbed points per time period. Artifact completeness and time period were tested using a chi-square test of independence at an alpha level of 0.01, all time periods 2500 BP and older were combined for this test. Artifact completeness was found to be independent of time period (Table 6.13). The equal proportions of complete to incomplete barbed points in each time period suggests similar discard or taphonomic processes for barbed points through time, important for this analysis due to the role of artifact completeness in assigning functional classes.

Table 6.11 shows the sample sizes and percentages of each functional class. Fixed points were the most common type of barbed point (N=129) followed by retrievable points (N=109). Leisters were much less common than either fixed or retrievable points (N=33), while unibarbed points (i.e. fish hooks) were the least common type of artifact. Fire modification was recorded due to the possibility of its importance in the discard of barbed points and its noted significance in ethnographic accounts as an identity marker. Few artifacts exhibited signs of burning (N=18) and none were calcined. None of the fired modified artifacts were burned in a manner indicative of burning for personal identity markers (linear burns).

Table 6.10. Artifact Completeness and Sample Size by 500-year BP Period.

			500-year BP Period									Total
			500	1000	1500	2000	2500	3000	3500	4500	6000	
Complete/ Incomplete	Complete	Count (Rank)	16 (2)	12 (2)	7 (2)	41 (2)	5 (2)	6 (2)	1 (2)	1 (2)	1 (2)	90
		% Complete	17.8%	13.3%	7.8%	45.6%	5.6%	6.7%	1.1%	1.1%	1.1%	100.0%
		% within 500-year BP Period	22.2%	11.4%	20.0%	17.7%	26.3%	27.3%	5.3%	16.7%	33.3%	17.5%
	Incomplete	Count (Rank)	59 (1)	97 (1)	28 (1)	191 (1)	14 (1)	9 (1)	18 (1)	5 (1)	2 (1)	423
		% Incomplete	13.2%	22.0%	6.6%	45.2%	3.3%	3.8%	4.3%	1.2%	.5%	100.0%
		% within 500-year BP Period	77.8%	88.6%	80.0%	82.3%	73.7%	72.7%	94.7%	83.3%	66.7%	82.5%
Total		Count	75	109	35	232	19	15	19	6	3	513

Table 6.11. Functional Class Sample Sizes.

Class	Count (Rank)	Percent
Fixed Point	129 (1)	44.32
Retrievable Point	109 (2)	37.45
Leister	33 (3)	11.34
Fish Hook	20 (4)	6.87
Total	291	100

302 Artifacts were too fragmentary to be assigned a functional class.

Variation in Barbed Point Types and Traits

The analysis of barbed points has been divided into an examination of functional, stylistic, and chronological variation. The functional and stylistic variation of barbed point types and traits was examined through the use of regression to determine correlations between metric traits. These correlations were then examined by functional class. Attributes which did not strongly covary by functional class were designated as stylistic. The chronological variation of traits was examined using 500-year BP periods in order to determine whether the chronological trends in barbed point morphology reported by McMurdo (1972) were present in this sample. The primary goal of these analyses was to ensure that the morphological traits used in the cladistics analysis, shaft barbs, were present in all functional classes and time periods and that their variation was not strongly tied to other attributes. This was to ensure that the traits used in the cladistics analysis were shared, derived, stylistic traits.

Summary Statistics

Descriptive statistics (Table 6.12) and histograms (Figures 6.6 through 6.20) have been provided for all metric attributes. Only complete points were included in statistics relating to projectile length. Bone and antler points tend to rarely break longitudinally, meaning that width measures should be accurate for most fragmentary artifacts. All metric attributes appear to have unimodal distributions. All distributions, with the exception of projectile length, head barb angle, and shaft barb angle, were positively skewed. Head barb angle and shaft barb angles were negatively skewed. These skews, I argue, may be the result of manufacturing constraints for squared barbs, which have narrow barb angles. The mean barb angle for squared barbs was 30 degrees, while straight and convex barbs have a mean barb angle of over 45 degrees. The histograms of barb angles also demonstrate clear breaks, which are attributable to angle measurements being rounded to the nearest five degrees. Maximum projectile width, and maximum shaft barb width distributions were highly leptokurtic. Fixed points comprised significant portion of the sample and this may reflect strong functional constraints in that class. Projectile length was closest to a standard normal distribution. This may be the result of a small sample of barbed unipoints, which had smaller length measures than other barbed point types. As the majority of these distributions are not normal, the Kruskal-Wallis test will be used to compare the mean ranks of barbed point metric attributes by functional class.

Table 6.12. Metric Character Descriptive Statistics.

	Count	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Skewness Std. Error	Kurtosis	Kurtosis Std. Error
Projectile Length[1]	111	162	43	205	118	36	0.12	0.23	-2.99	0.46
Maximum Projectile Width	593	76	2	78	12	6.4	3.2	0,1	20.6	0.2
Maximum Projectile Thickness	593	20.5	0.5	21	6.1	2.3	2	0.1	7.3	0.2
Head Length[1]	111	74.26	3.4	77.66	25.8	14.35	1	0.23	0.92	0.46
Maximum Head Width	294	25	1	26	9.62	4.67	1.59	0.14	2.26	0.28
Maximum Head Barb Width	277	14	0	14	3.42	2.45	1.85	0.15	3.67	0.29
Head Barb Angle	279		0	80	36.89	16.5	-0.79	0.15	-0.41	0.29
Shaft Length[1]	103	109.88	14.3	124.18	53.94	26.46	0.72	0.24	-0.05	0.47
Maximum Shaft Width	544		1	40	11.54	5.16	1.7	0.11	3.47	0.21
Maximum Shaft Barb Width	458	25	0	26	3.81	2.85	2.71	0.11	12.39	0.23
Shaft Barb Angle	450	85	0	85	37.47	16.76	-0.58	0.12	-0.41	0.23
Maximum Line Attachment Width	106	31	3	34	15.96	7.47	0.73	0.24	-0.22	0.47
Line Attachment Length[1]	31	60.64	0	60.64	17.64	13.98	1.33	0.42	1.16	0.82
Base Width	276	26	0	26	6.55	4.94	1.34	0.15	1.75	0.29
Base Length[1]	110	88.23	4.1	92.33	37.44	18.7	0.49	0.23	-0.31	0.46

[1]Only complete artifacts examined for length measures

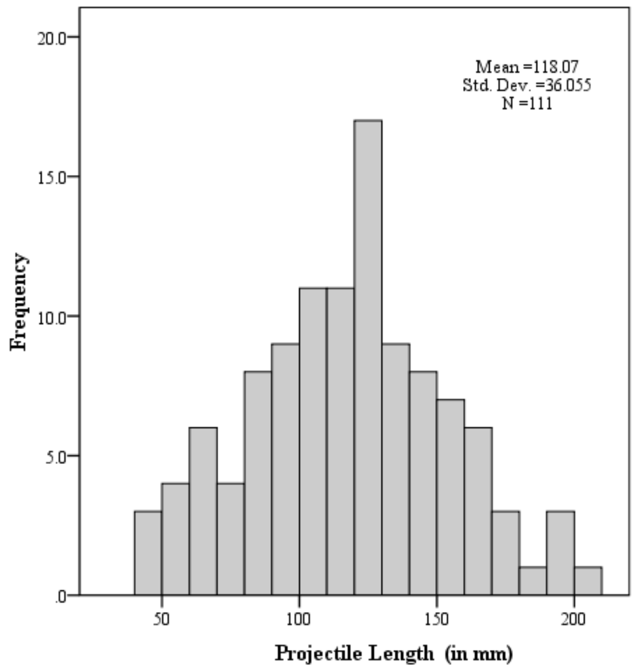


Figure 6.6. Projectile Length.

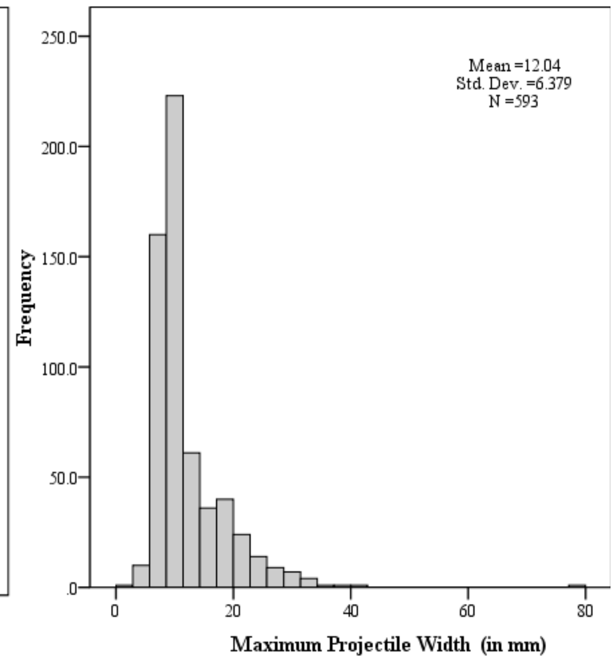


Figure 6.7. Maximum Projectile Width.

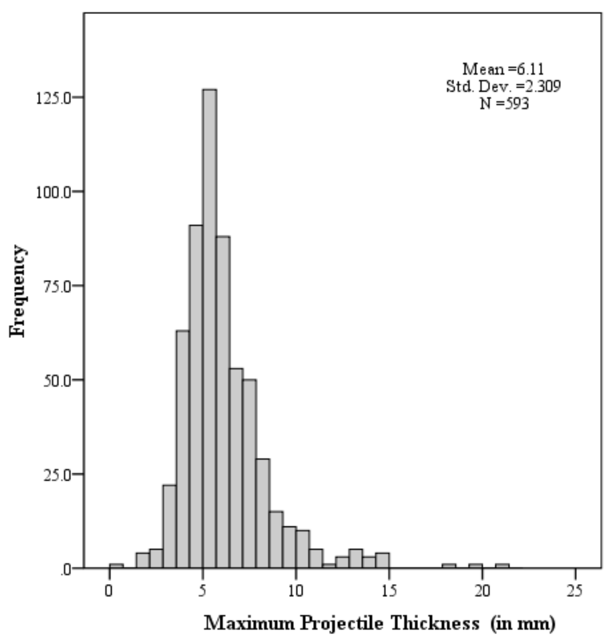


Figure 6.8. Maximum Projectile Thickness.

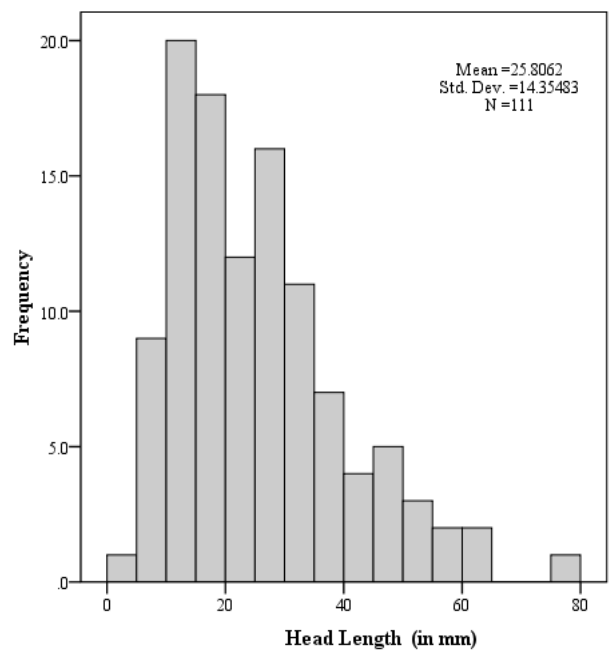


Figure 6.9. Head Length.

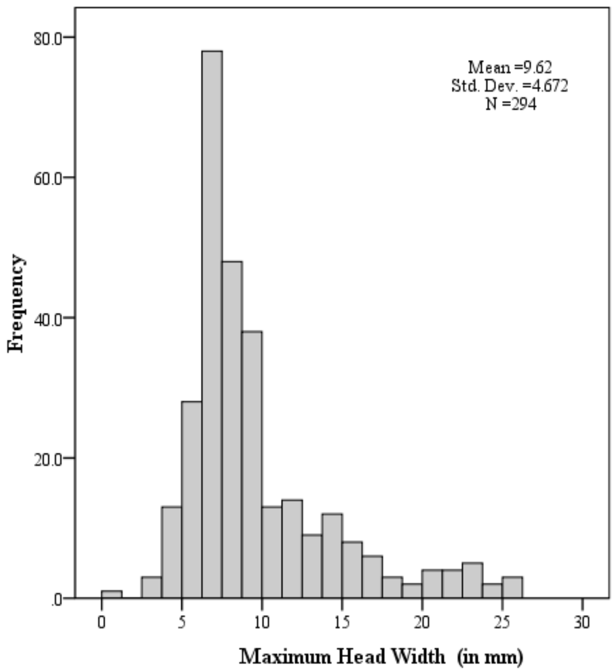


Figure 6.10. Maximum Head Width.

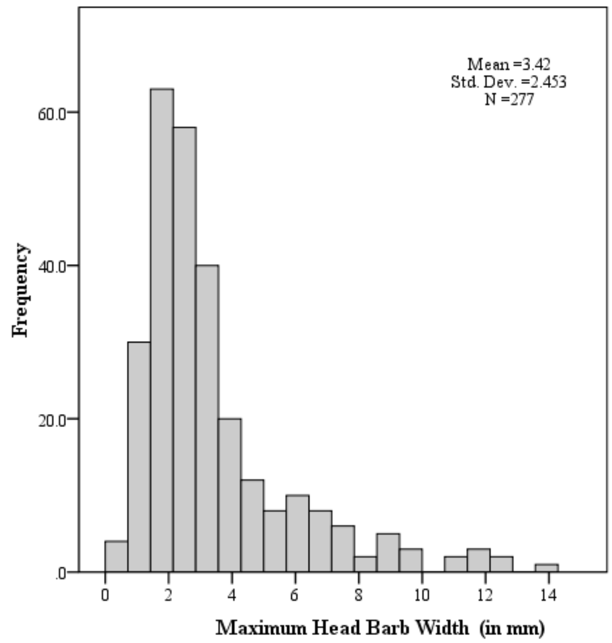


Figure 6.11. Maximum Head Barb Width.

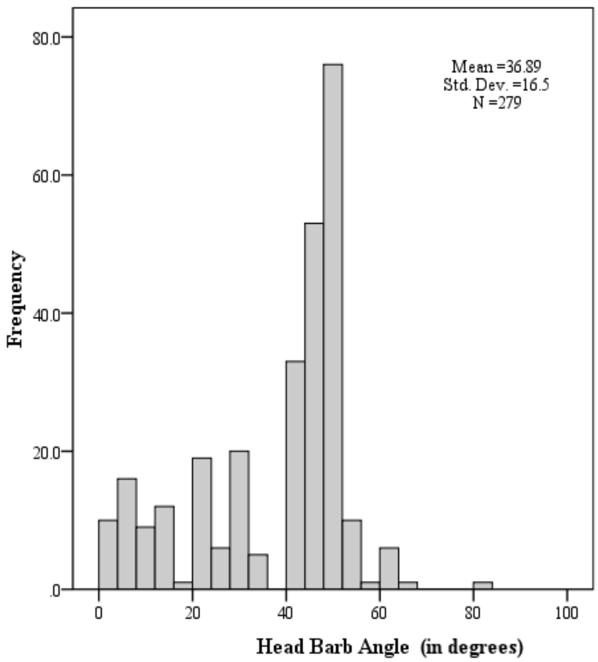


Figure 6.12. Head Barb Angle.

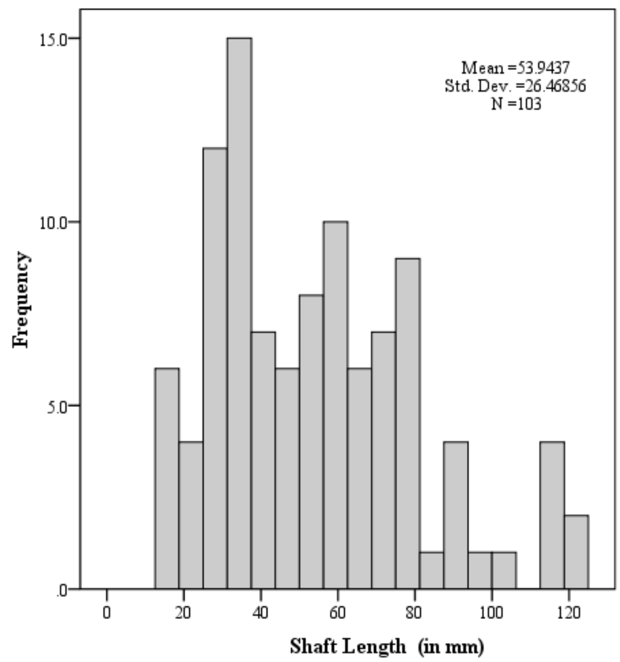


Figure 6.13. Shaft Length.

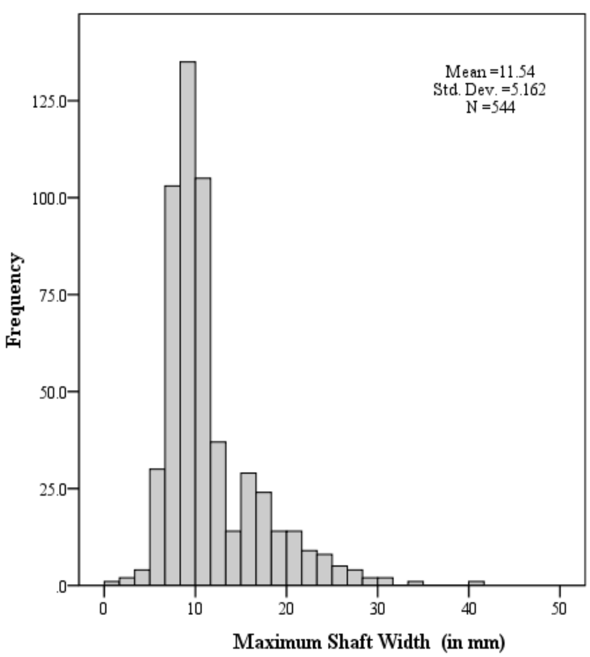


Figure 6.14. Maximum Shaft Width.

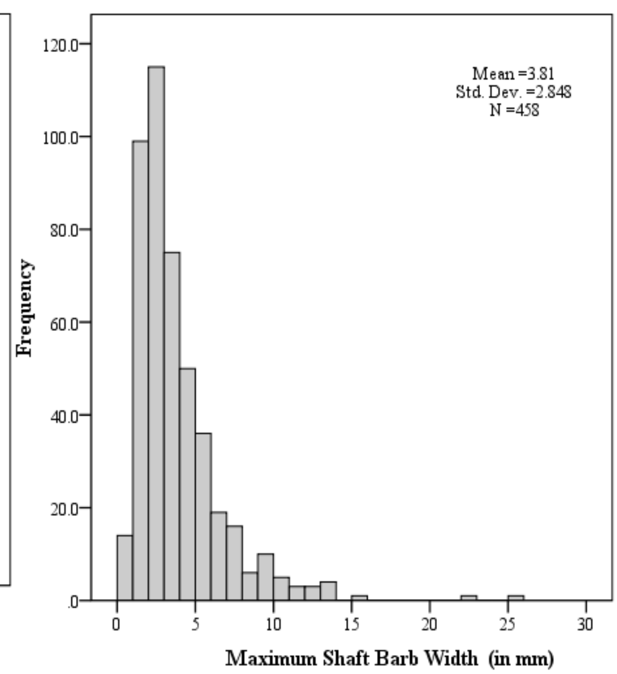


Figure 6.15. Maximum Shaft Barb Width.

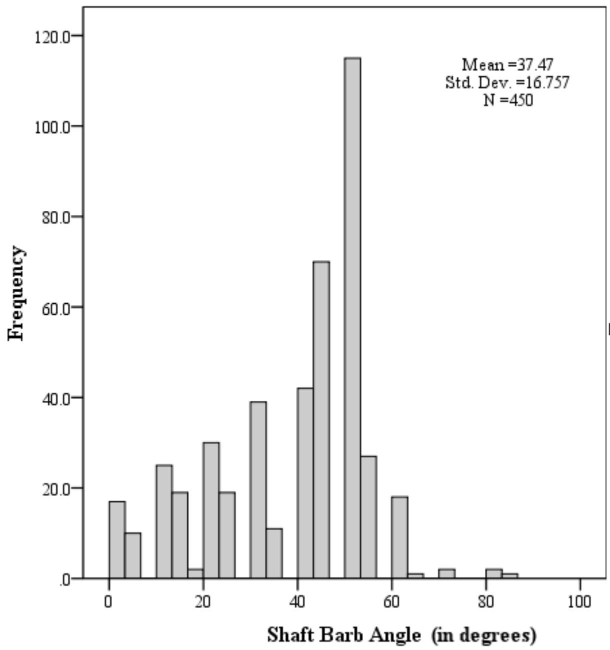


Figure 6.16. Shaft Barb Angle.

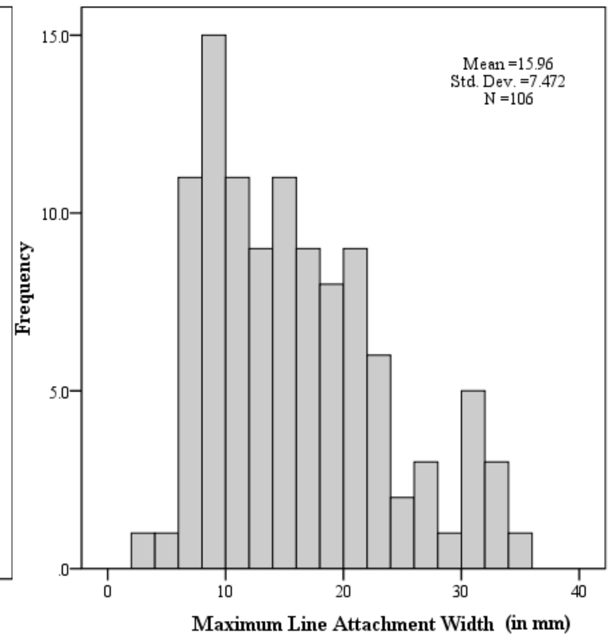


Figure 6.17. Maximum Line Attachment Width.

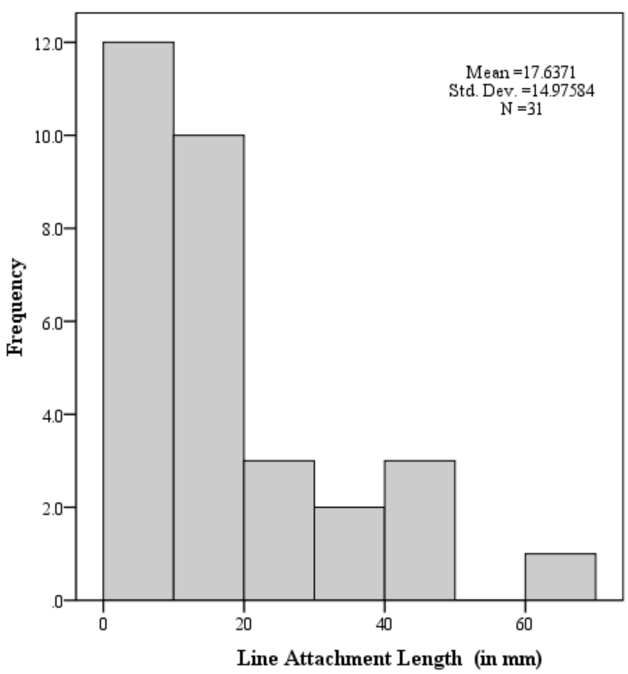


Figure 6.18. Line Attachment Length.

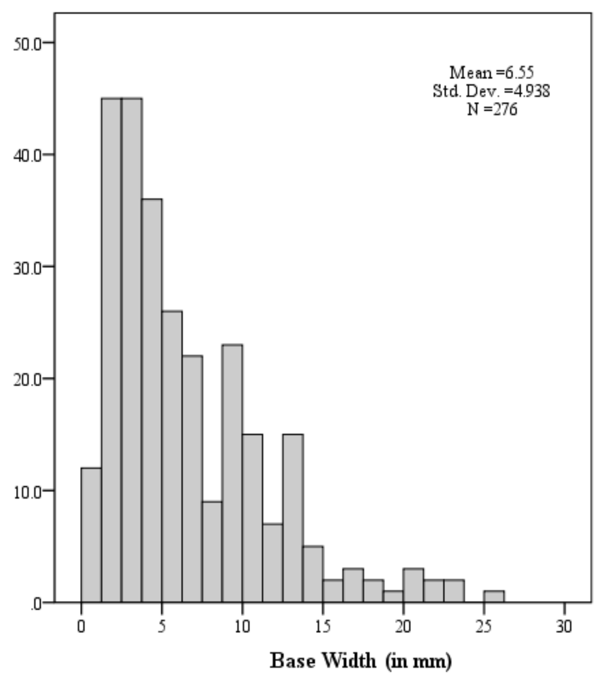


Figure 6.19. Base Width.

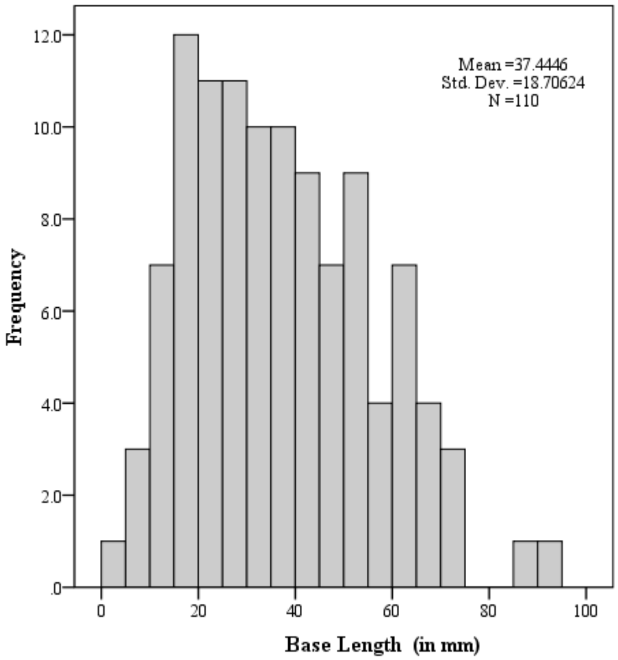


Figure 6.20. Base Length.

Functional and Stylistic Variation

Material, Metric Attributes, and Non-Metric Characters by Functional Classes

Both bone and antler were used as materials for all functional types, in varying proportions (Figure 6.21). Antler was utilized most frequently for retrievable points, and least frequently for barbed unipoints. In general, antler was the material used for robust points The mean width of antler points was 3 cm more than bone points while the mean thickness of antler points was 2 cm more than bone points. These differences can be attributed to material constraints, as antler tools are typically thicker and wider than those from metapodial bone.

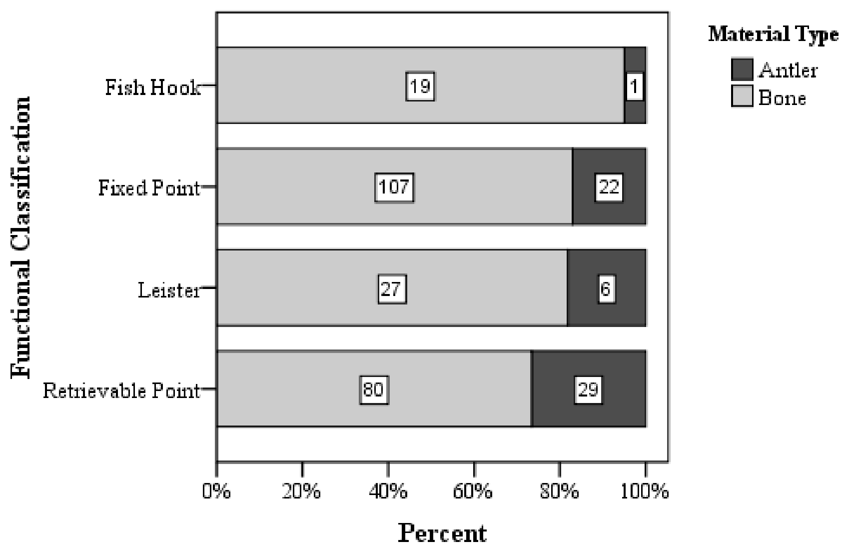


Figure 6.21. Material Type by Functional Class (N=291).

Variation in attributes according to functional class was examined to determine whether or not there were distinct metric differences between functional types. Retrievable points were expected to be longer and wider than fixed points and leisters, while fish hooks were predicted to be shorter than other point types. No significant differences in barb attributes were predicted between functional classes, with the exception of barb width. Barb width should vary with maximum projectile width, which may vary by functional class. Figures 6.22 through 6.33 display differences in metric attributes according to functional class. In each figure, case numbers for outliers are provided. Cases that are between 1.5-3 inter-quartile ranges from the median are marked by circles, while cases over 3 inter-quartile ranges from the median are marked by asterisks. The majority of metric outliers date from the 1500-2500 BP time periods and are robust, barbed, antler points which are diagnostic of the Marpole period (e.g. Burley 1980, Mitchell 1990).

Both fixed and retrievable points demonstrate considerable metric variation compared to other functional classes. The lack of morphological variation seen in leisters and unibarbed points may be attributable to small sample sizes (N=16 and 12 respectively). Retrievable points are more variable in width (maximum width, head width, head barb width, shaft width, shaft barb width, and base width) and thickness than other functional classes. Retrievable points also appear to be considerably wider than other barbed point types (Figure 6.23). Fixed points demonstrate the most variation in length, which may be attributable to both their large sample size and wide range of functions. Fishhooks demonstrate the least variation in length (Figure 6.22). Fish hooks and leisters appear to be shorter than other classes. Using a Kruskal-Wallis test, differences in projectile length and maximum projectile width by functional class were statistically significant at a 0.01 level (Table 6.13). This supports the hypothesis that metric differences in length and width are attributable to function.

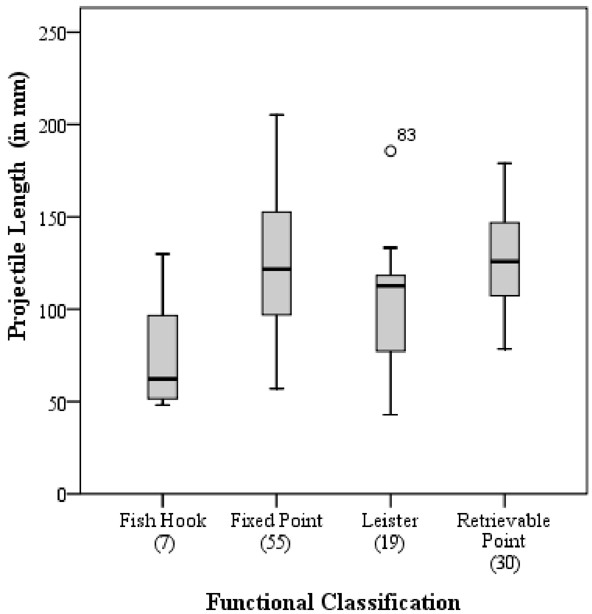


Figure 6.22. Complete Point Functional Class by Projectile Length (N=111).

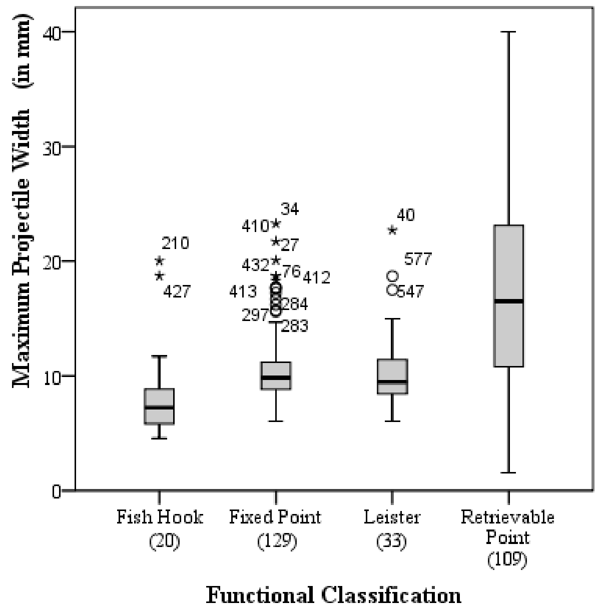


Figure 6.23. Functional Class by Maximum Projectile Width (N=291).

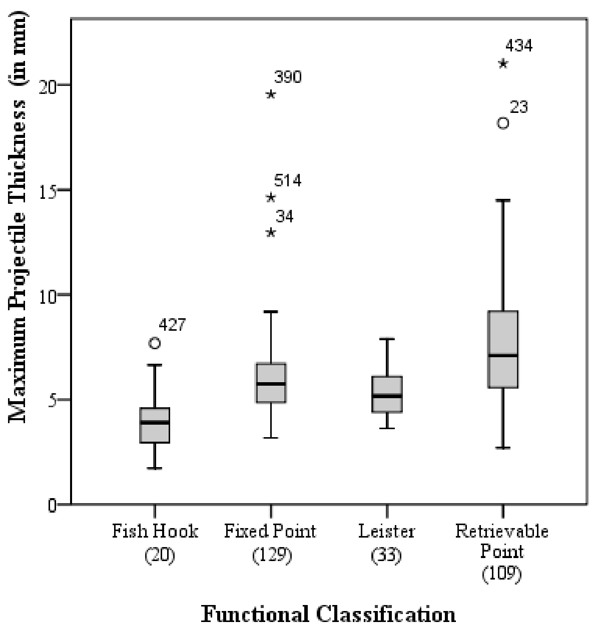


Figure 6.24. Functional Class by Maximum Projectile Thickness (N=291).

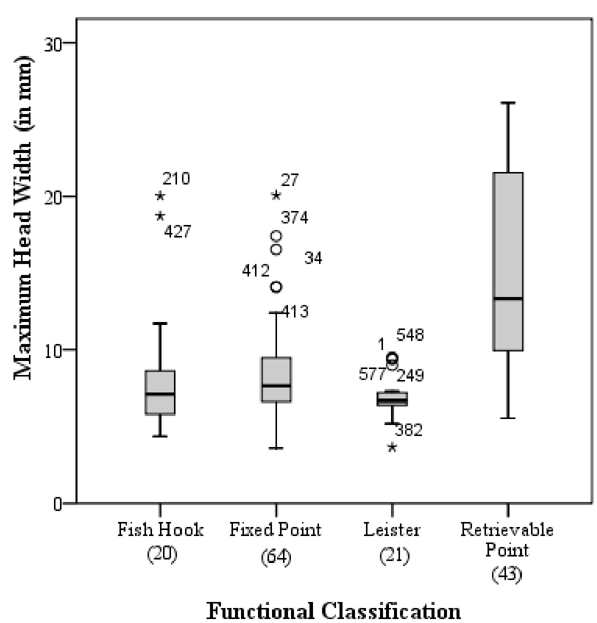


Figure 6.25. Functional Class by Maximum Head Width (N=148).

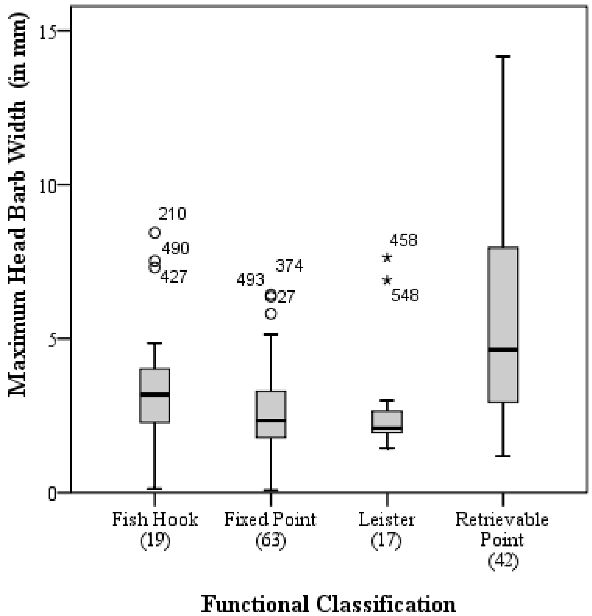


Figure 6.26. Functional Class by Maximum Head Barb Width (N=141).

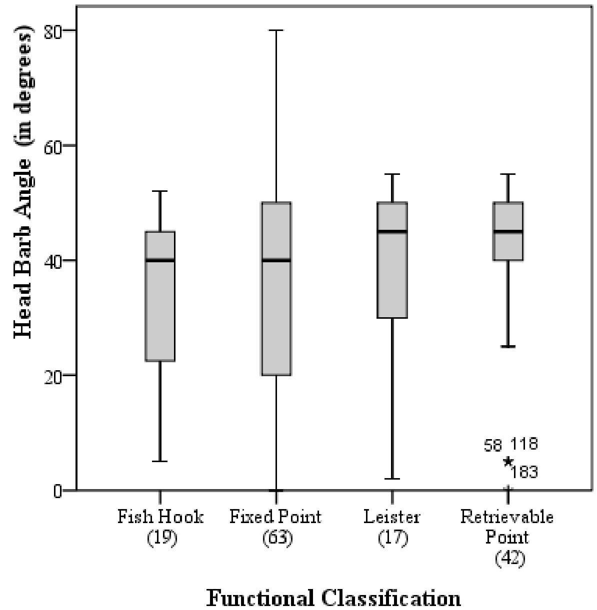


Figure 6.27. Functional Class by Head Barb Angle (N=141).

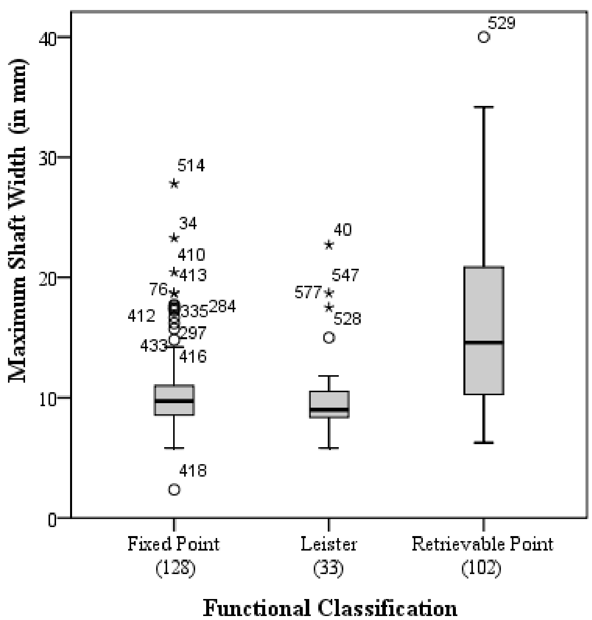


Figure 6.28. Functional Class by Maximum Shaft Width (N=263).

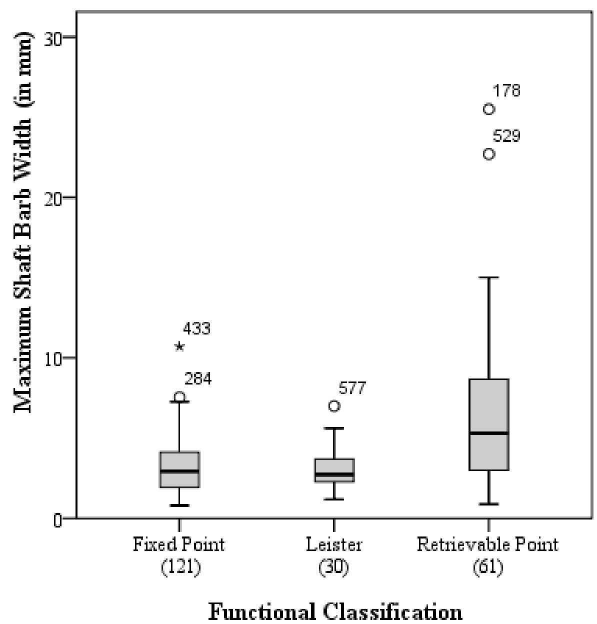


Figure 6.29. Functional Class by Maximum Shaft Barb Width (N=212).

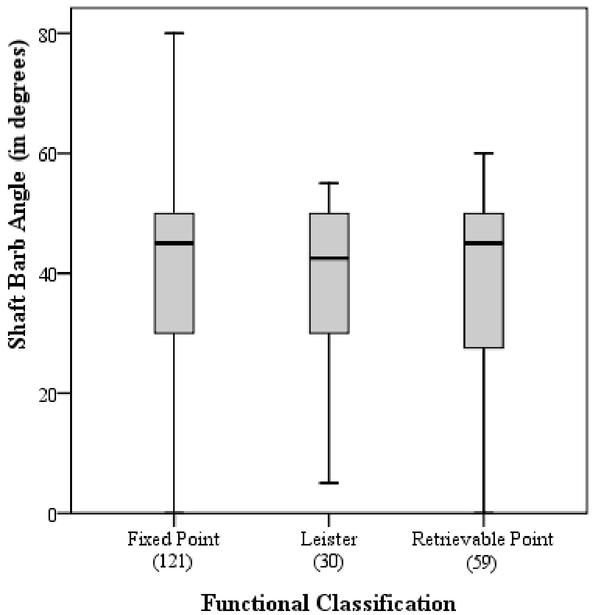


Figure 6.30. Functional Class by Shaft Barb Angle (N=210).

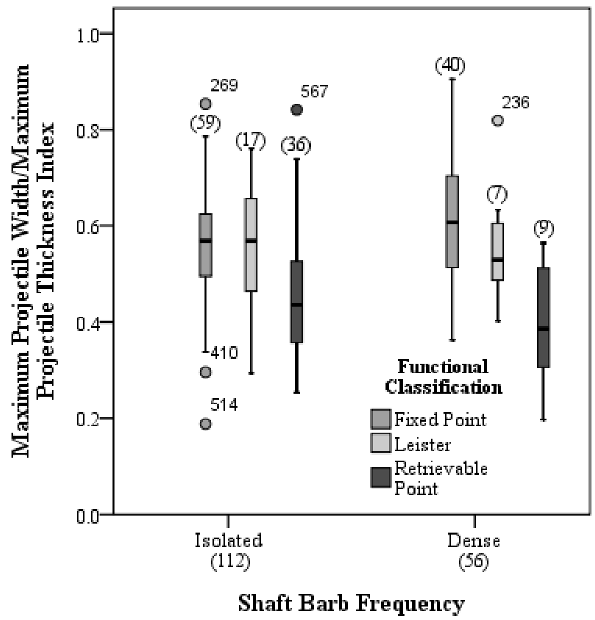


Figure 6.31. Maximum Projectile Width/Maximum Projectile Thickness by Shaft Barb Frequencies by Functional Class (N=271).

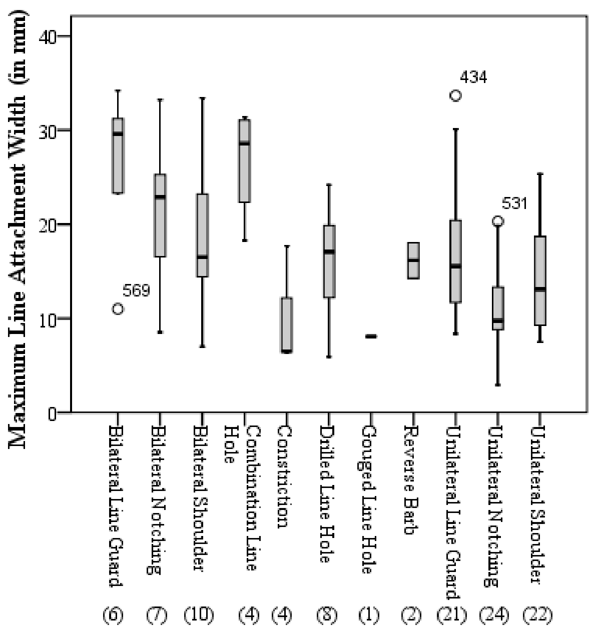


Figure 6.32. Maximum Width by Line Attachment Type (N=109).

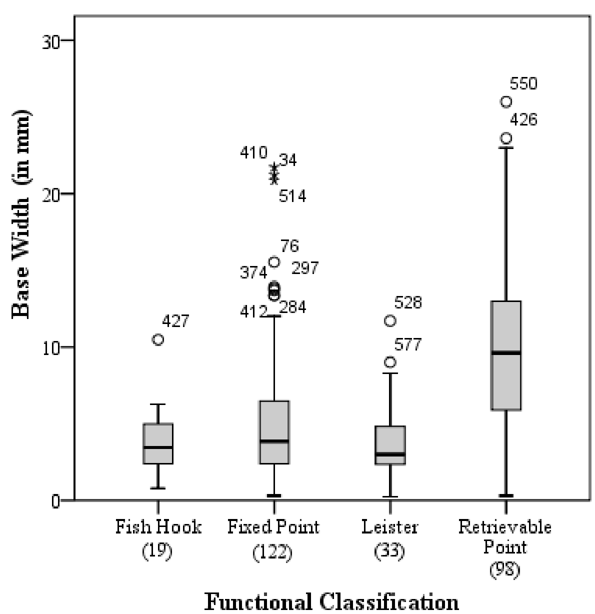


Figure 6.33. Functional Class by Base Width (N=272).

Table 6.13. Kruskal-Wallis and Chi-Square Tests.

Statistic	Test	N	df	α Level	χ^2 Crit	χ^2 Obs	p-value	H0(HA)
Kruskal-Wallis Test	Projectile Length by Functional Class	111	3	0.01	16.27	26.35	0.0000	HA
" "	Maximum Projectile Width by Functional Class	291	3	0.01	16.27	83.4	0.0000	HA
" "	Head Width by Functional Class	148	3	0.01	16.27	48.03	0.0000	HA
" "	Head Barb Angle by Functional Class	141	3	0.01	16.27	4.96	0.1747	H0
" "	Shaft Barb Angle by Functional Class	210	2	0.01	13.82	1.07	0.5856	H0
" "	Maximum Projectile Width/Maximum Projectile Thickness Ratio by Barb Density	291	1	0.01	10.83	2.51	0.1131	H0
" "	Base Width by Functional Class	272	3	0.01	16.27	69.82	0.0000	HA
" "	Base Length by Functional Class	110	3	0.01	16.27	16.84	0.0007	HA
" "	Fixed Point MPW/MPT Ratio by Presence/Absence of Conical Base	115	1	0.01	10.83	6.94	0.0084	H0
Chi-square Test of Independence	Artifact Completeness by Time Period	513	4	0.01	13.48	5.33	0.2548	H0
" "	Shaft Barb Shape by Functional Class	217	2	0.01	9.21	1.07	0.5844	H0
" "	Shaft Barb Silhouette by Functional Class	210	2	0.01	9.21	3.8	0.1498	H0
" "	Shaft Barb Shape by Time Period	394	5	0.01	15.09	24.54	0.0002	HA
" "	Microbarb Shape by Time Period	65	3	0.01	11.35	2.44	0.4860	H0
" "	Shaft Barb Ridge by Time Period	397	6	0.01	16.81	15.71	0.0277	HA
" "	Shaft Barb Silhouette by Time Period	396	6	0.01	16.81	12.72	0.0477	HA

All tests one-tailed

Barb application also varied by functional class; all bilaterally barbed points complete enough to be assigned a functional class were retrievable points. These demonstrate considerable morphological variation in maximum head width and head barb width values, and differences by functional class were statistically significant at a 0.01 level (Table 6.13). Fixed points also show more variation in head barb angle than other classes, followed by leisters (Figure 6.27). There was no statistically significant difference in head barb angles by functional class (Table 6.13). While having a similar mean as other functional classes, the head barb angles of retrievable points demonstrated less variation than other barbed point types. This, I argue, was not a result of sample size, as both unibarb points and leisters demonstrated variation in head barb angles than retrievable points and had much smaller sample sizes. This difference in head barb angle variation may be reasonably attributed to functional constraints. Retrievable points would have broad straight or convex head barbs precluding acute angles.

Counts of non-metric characters by functional class are provided in Tables 6.14 through 6.19. Chi-square tests could not be performed on head barb shape/functional class and microbarb shape/functional class cross tabulations due to a high number of missing values. As these were not 2x2 contingency tables, Yate's correction could not be utilized. However, a chi-square test for shaft barb shape could be performed by combining the frequencies of straight and squared barbs. Shaft barb shape and functional class were independent (Table 6.13).

Table 6.14. Head Barb Shape by Functional Class.

			Functional Class				Total
			Fish Hook	Fixed Point	Leister	Retrievable Point	
Head Barb Shape	Convex	Count (Rank)	1 (3)	0 (2.5)	2 (2)	4 (2)	7
		% within Head Barb Shape	14.3%	.0%	28.6%	57.1%	100.0%
		% within Functional Class	5.0%	.0%	11.8%	9.3%	4.8%
	Squared	Count (Rank)	3 (2)	0 (2.5)	0 (3)	2 (3)	5
		% within Head Barb Shape	60%	.0%	.0%	40%	100.0%
		% within Functional Class	15.0%	.0%	.0%	4.6%	3.4%
	Straight	Count (Rank)	16 (1)	63 (1)	15 (1)	37 (1)	131
		% within Head Barb Shape	12.2%	48%	11.5%	28.2%	100.0%
		% within Functional Class	80.0%	100%	88.2%	86%	91.6%
Total		Count	20	63	17	43	143
		% within Head Barb Shape	14%	44%	11.8%	30%	100.0%

Table 6.15. Shaft Barb Shape by Functional Class.

			Functional Class			Total
			Fixed Point	Leister	Retrievable Point	
Shaft Barb Shape	Convex	Count (Rank)	2 (3)	1 (3)	4 (3)	7
		% within Shaft Barb Shape	28.6%	14.3%	57.1%	100.0%
		% within Functional Class	1.6%	3.3%	6.6%	1.7%
	Squared	Count (Rank)	36 (2)	6 (2)	18 (2)	60
		% within Shaft Barb Shape	60%	10%	30%	100.0%
		% within Functional Class	29.5%	20%	30.00%	28.4%
	Straight	Count (Rank)	84 (1)	23 (1)	38 (1)	145
		% within Shaft Barb Shape	58%	15.9%	26.2%	100.0%
		% within Functional Class	68.8%	76.6%	63.3%	69.8%
Total		Count	122	30	60	212
		% within Shaft Barb Shape	26.7%	6.5%	13.1%	100.0%

Table 6.16. Shaft Barb Silhouette by Functional Class.

			Functional Class			Total
			Fixed Point	Leister	Retrievable Point	
Shaft Barb Silhouette	Enclosed	Count (Rank)	64 (1)	12 (2)	23 (2)	99
		% within Shaft Barb Shape	64.6%	12.1%	50.0%	23.23%
		% within Functional Class	52.8%	40%	6.6%	47.1%
	Extended	Count (Rank)	57 (2)	18 (1)	36 (1)	111
		% within Shaft Barb Shape	51.4%	16.2%	32.4%	100.0%
		% within Functional Class	47.1%	60%	61%	47.1%
Total		Count	121	30	59	210
		% within Shaft Barb Shape	57.6%	14.3%	28.1%	100.0%

Table 6.17. Shaft Barb Extension by Functional Class.

			Functional Class			Total
			Fixed Point	Leister	Retrievable Point	
Shaft Barb Extension	High	Count (Rank)	9 (2)	1 (2)	9 (2)	19
		% within Shaft Barb Shape	47.4%	5.2%	47.4%	100.0%
		% within Functional Class	7.4%	3.3%	15.51%	9%
	Low	Count (Rank)	112 (1)	29 (1)	49 (1)	190
		% within Shaft Barb Shape	58.9%	15.3%	25.8%	100.0%
		% within Functional Class	92.6%	96.6%	84.4%	91%
Total		Count	121	30	58	209
		% within Shaft Barb Shape	57.9%	14.4%	27.8%	100.0%

Table 6.18. Microbarb Type by Functional Class.

			Functional Class				Total
			Fish Hook	Fixed Point	Leister	Retrievable Point	
Microbarb Type	Grooved	Count (Rank)	1 (1.5)	13 (1)	2 (1)	10 (1)	26
		% within Microbarb Type	3.8%	50.0%	7.6%	38.4%	100.0%
		% within Functional Class	50.0%	61.9%	66.6%	58.8%	60.4%
	Notched	Count (Rank)	1 (1.5)	8 (2)	1 (2)	7 (2)	17
		% within Microbarb Type	5.8%	47.1%	5.8%	41.2%	100.0%
		% within Functional Class	50.0%	38.10%	33.3%	41.2%	39.6%
Total		Count	2	21	3	17	43
		% within Microbarb Type	4.7%	48.8%	7%	39.5%	100.0%

Table 6.19. Base Shape by Functional Class.

			Functional Class				Total
			Fish Hook	Fixed Point	Leister	Retrievable Point	
Base Shape	Conical	Count (Rank)	2 (2.5)	31 (3)	6 (3)	4 (4.5)	43
		% within Base Shape	4.7%	72.1%	14.0%	9.3%	100.0%
		% within Functional Class	22.2%	27.0%	18.2%	4.5%	17.47%
	Flanged	Count (Rank)	0 (5)	0 (5)	2 (4)	4 (4.5)	6
		% within Base Shape	.0%	.0%	33.3%	66.7%	100.0%
		% within Functional Class	.0%	.0%	6.1%	4.5%	2.4%
	Rounded	Count (Rank)	4 (1)	37 (2)	15 (1)	26 (2)	82
		% within Base Shape	4.9%	45.1%	18.2%	31.7%	100.0%
		% within Functional Class	44.4%	32.2%	45.5%	29.2%	33.3%
	Squared	Count (Rank)	1 (4)	2 (4)	1 (5)	13 (3)	17
		% within Base Shape	5.9%	11.8%	5.9%	76.5%	100.0%
		% within Functional Class	11.1%	1.7%	3.0%	14.6%	6.9%
	Wedged	Count (Rank)	2 (2.5)	45 (1)	9 (2)	42 (1)	98
		% within Base Shape	2.0%	45.6%	9.2%	42.9%	100.0%
		% within Functional Class	22.2%	39.1%	27.3%	47.1%	39.8%
Total		Count	9	115	33	89	246
		% within Base Shape	3.7%	46.7%	13.4%	36.2%	100.0%

A high degree of variation is seen in shaft barb angle regardless of functional class (Figure 6.30): however these differences are not statistically significant at a 0.01 level (Table 6.13). The lack of difference in shaft barb angles by functional class, unlike head barb angle, may indicate that shaft barbs are not under the same functional pressures as head barbs. However, both head and shaft barb angles are tied to the overall shape of the barb, with squared barbs having smaller angles than squared or convex barbs. This was expected due to the nature of the barb shape classification. Head and shaft barb shape maintain the same relative frequencies regardless of functional class. Straight barbs are the most common, followed by squared and convex barbs.

In order to test Clark's (1975:129-130) hypothesis regarding the functional role of barb density, shaft barb density was examined by functional class and maximum projectile width/thickness ratio (Figure 6.16). When examining width/thickness ratios by functional class and barb density (Figure 6.31), it is clear while there is substantial overlap, fixed points with denser barbs tend to have more circular profiles. Retrievable points and leisters demonstrate a different pattern (Figure 6.31), as these points with isolated barbs, have a more circular profile, on average, while those with dense barbs have more lenticular profiles (low width/thickness ratios). Differences in mean width/thickness index ratio by barb density category were not significant at a 0.01 level (Table 6.13). While not significant, a trend is apparent which may indicate that a combination of Clark and Carlson's inferences are correct. Barb density may, in fact, not be directly tied to function, but vary due to manufacturing constraints related to point profile.

In the case of both fixed points and leisters with circular profiles, I suggest that denser barbs are proposed to be a functional solution for breakage. Multiple, dense barbs could mean that less force is exerted on a barb when retrieving a point. With retrievable points, I suggest the barb density of lenticular-profiled points is higher for much the same reason. Retrievable points with circular profiles would tend have thicker, isolated, barbs that would tend to not break. Whereas, the thinner barbs of retrievable points with lenticular profiles would have a higher tendency to break. Increasing the barb density of lenticular profiled retrievable points could be a means of compensation. Experimentation with barbed points of varying profiles and barb densities is recommended to test the inferences made here.

Shaft barb silhouette varies by functional class (Table 6.16). Both leisters and retrievable points have similar proportions of enclosed to extended barbs, while more fixed points have enclosed barbs. However, these differences are not statistically significant at a 0.01 level as shaft barb silhouette is independent of functional class (Table 6.13). Shaft barb extension does not appear to vary by functional class either, as high shaft barbs are relatively rare in the sample (Table 6.17). While microbarbs were rare in general, they were absent from almost all fish hooks and leisters (Table 6.17). Grooved microbarbs were in general the most common type of microbarb among artifacts that were assigned a functional class.

Differences in the width of line attachment types were also found (Figure 6.32). Line attachment types associated with the Marpole period such as bilateral line guards, bilateral shoulders, and combination line holes exhibit the greatest widths, consistent with metric outliers dating from this period. Base morphology exhibited more variation between functional classes than barb shape (Table 6.19). Base morphology classes could not be combined for a chi-square analysis without losing meaningful distinctions. So no chi-square test was run. Conical bases were most common with fixed points, which may indicate that conical bases have functional significance as suggested by Carlson (1954:24). A conical base may indicate that a fixed point is a bird arrow. Similarly, squared bases were most common with retrievable points. Retrievable and fixed points shared base type rank order for their two most common base types (wedged and rounded bases) while the rank order of leister bases differed. Rounded bases are the most common type for leisters, followed by flanged (an asymmetrical base type which by definition would be unique to leisters) and wedged bases. The rank order for fish hook bases is similar to leisters in that rounded bases were the most common type. The small sample size of barbed unipoints however resulted in ties in the rank order of conical and wedged bases.

Retrievable point bases were significantly wider than those of other barbed point types (Table 6.13). The clear metric differences between retrievable point bases and those of other functional classes and the prevalence of conical bases with fixed points shows that morphological variation of barbed point bases is strongly affected by function. Certain base types may be functionally equivalent, while others, such as conical and flanged bases, may be distinct solutions for functional problems. Flanged bases, for instance, enable side-hafting of leisters.

Overall, retrievable points were the most robust barbed bone and antler points. Fixed, straight points, however, exhibit the most morphological variation. Barbed unipoints (i.e. fish hooks) in general were narrower, thinner, and shorter than the other functional classes. These differences in projectile length and width by functional class were found to be significant at a 0.01 level (Table 6.13). While differences exist in barb width, barb characters such as shape appear to be consistent between all functional classes. This pattern suggests an intellectual lineage or cultural tradition independent of the functional type.

Regression/Correlation

Regression and correlation were used to investigate the relationships between metric attributes. Strong relationships between all width measures were predicted as a result of barbed point construction constraints. Similarly, strong correlations between thickness, length, and width were expected. These correlations were predicted primarily due to material constraints. If, for instance, projectile width varied too greatly between projectile segments, or if a projectile was too thin overall for its width, the structural integrity of the point could be compromised resulting in breakage. Line attachment width and base width were also expected to be strongly correlated.

Correlations between all metric characters were examined using Spearman's Rho, as metric attributes did not have normal distributions. Rho values over 0.5 or less than -0.5 are reported in Table 6.20. In general, strong correlations were tied to metric characters that were expected to covary, such as, projectile width with segment width measures, and barb width with segment width. Projectile thickness was also strongly correlated with width measures, as was line attachment width with base width. Unexpectedly, projectile length strongly correlated only with maximum head length and maximum shaft length, but not with other metric attributes. This means that barbed points demonstrate considerable morphological variation in length, which may not be strongly constrained by the thickness or width of the material. Negative correlations were detected between base length and all width attributes. This indicates a tendency for narrower barbed points to have longer bases, either for the purposes of hafting (leisters) or insertion in a foreshaft (fixed points used as barbed arrows).

Table 6.20. Metric Character Spearman's Rho Correlations.

		Maximum Projectile Width	Maximum Projectile Thickness	Projectile Length	Head Length	Maximum Head Width	Maximum Head Barb Width	Shaft Length	Maximum Shaft Width	Maximum Shaft Barb Width	Maximum Line Attachment Width	Line Attachment Length	Base Width	Base Length
Maximum Projectile Width	Correlation Coefficient	1												
	Sig. (2-tailed)	.												
	N	593												
Maximum Projectile Thickness	Correlation Coefficient	.688**	1											
	Sig. (2-tailed)	0	.											
	N	593	593											
Projectile Length[1]	Correlation Coefficient	.311**	.314**	1										
	Sig. (2-tailed)	0	0	.										
	N	111	111	111										
Head Length	Correlation Coefficient	.275**	.274**	.506**	1									
	Sig. (2-tailed)	0	0	0										
	N	294	294	111	294									
Maximum Head Width	Correlation Coefficient	.804**	.592**	.290**	.550**	1								
	Sig. (2-tailed)	0	0	0	0	.								
	N	294	294	111	294	294								
Maximum Head Barb Width	Correlation Coefficient	.655**	.476**	0.89	.339**	.742**	1							
	Sig. (2-tailed)	0	0	0.37	0	0	.							
	N	277	277	106	277	277	277							
Shaft Length	Correlation Coefficient	.235**	.222**	.630**	-0.08	0	0.02	1						
	Sig. (2-tailed)	0	0	0	0.23	0.99	0.81	.						
	N	545	545	103	254	254	242	545						
Maximum Shaft Width	Correlation Coefficient	.948**	.646**	.296**	.219**	.746**	.652**	.302**	1					
	Sig. (2-tailed)	0	0	0	0	0	0	0	.					
	N	544	544	103	254	254	242	544	544					
Maximum Shaft Barb Width	Correlation Coefficient	.666**	.517**	.082**	0.1	.535**	.683**	.209**	.684**	1				
	Sig. (2-tailed)	0	0	0.43	0.16	0	0	0	0	.				
	N	458	458	92	209	209	199	458	458	458				
Maximum Line Attachment Width	Correlation Coefficient	.854**	.696**	.450**	0.2	.779**	.686**	0.11	.785**	.756**	1			
	Sig. (2-tailed)	0	0	0	0.2	0	0	0.27	0	0	.			
	N	110	110	33	44	44	43	104	104	61	110			
Line Attachment Length	Correlation Coefficient	.224*	.249**	.425**	.434**	0.18	0.13	0	.232*	0.02	.232*	1		
	Sig. (2-tailed)	0.02	0.01	0	0	0.26	0.41	0.97	0.02	0.91	0.02	.		
	N	110	110	33	44	44	43	104	103	60	109	110		
Base Width	Correlation Coefficient	.628**	.499**	.383*	.361**	.594**	.478**	.148*	.596**	.425**	.610**	0.05	1	
	Sig. (2-tailed)	0	0	0.02	0	0	0	0.02	0	0	0	0.64	.	
	N	276	276	110	141	141	134	248	247	201	102	103	276	
Base Length	Correlation Coefficient	-0.1	0	.397**	.226**	-0.09	-.237**	0.02	-.175**	-.192**	0.08	-0.06	-.250**	1
	Sig. (2-tailed)	0.11	0.95	0	0.01	0.27	0.01	0.77	0.01	0.01	0.41	0.54	0	.
	N	277	277	110	141	141	134	249	248	202	102	103	276	277

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

[1] Only complete artifacts reported

r^2 values >0.5 or <-0.5 shaded

Principle Component Analysis

Principle Component analysis (PCA), a method of exploratory factor analysis, was used to summarize relationships in the metric portion of the dataset. King (2007:59-60) used principle component analysis for this purpose in her examination of small bone points from the T'ukw'aa site. Principle component analysis searches for sets of intercorrelated variables and groups them into subsets called 'principle components'. The first principle component attempts to account for as much of the variation in the data set as possible, with subsequent components attempting to account for as much of the variation remaining as possible (Everitt and Dunn 1991). Components may be plotted on a scatter plot, where the axes of the graph represent the axes of maximum variance. Hoffman (1995) argues that this is useful for summarizing the dimensions of a multivariate dataset, while others have found this method useful for exploring groupings in a dataset (e.g. Banning 2000, Baxter 2003).

Metric attributes of complete artifacts (N=111) were used for the principle component analysis. Only attributes shared by all functional classes were used in this analysis, therefore shaft and line attachment attributes were omitted. All data were standardized to Z-Scores. Component 1 (Table 6.21) accounted for 48.35% of the variance in the dataset and had high factor loadings for maximum projectile width, maximum projectile thickness, maximum head width, maximum head barb width, and base width. As the value of Component 1 increases, projectiles become more robust, that is both wider and thicker. Component 2 accounted for 18% of the variance, and had high factor loadings for projectile length and base length, and had a moderate negative loading for head barb angle. As the value of Component 2 increases, projectiles become longer and have narrower head barb angles. Head barb angle I argue has functional importance as the head barb serves as the arming element of the barbed point. The correlation between projectile length and head barb angle seen in Component 2 may indicate differences in barbed point arming elements for points of different lengths.

The principle component scatter plot (Figure 6.34) did not indicate discrete groups of objects. However, there are general trends. Retrievable points tend to have higher Component 1 values, while leisters and fixed points tend to have low Component 1 values. Leisters and fixed points demonstrate considerable variation in Component 2 values, although retrievable points and fish hooks tend to have lower values indicating a tendency towards shorter lengths. While there is substantial variation in the sample, projectile length and width appear to vary by functional class, confirming the patterns seen in the univariate analyses.

Table 6.21. Principle Component Analysis Matrix.

	Component	
	1	2
Projectile Length	0.43	0.75
Maximum Projectile Width	0.93	-0.1
Maximum Projectile Thickness	0.81	-0.16
Head Length	0.55	0.44
Maximum Head Width	0.93	-0.5
Maximum Head Barb Width	0.85	-0.22
Head Barb Angle	0.31	-0.54
Base Width	0.79	-0.07
Base Length	-0.15	0.77

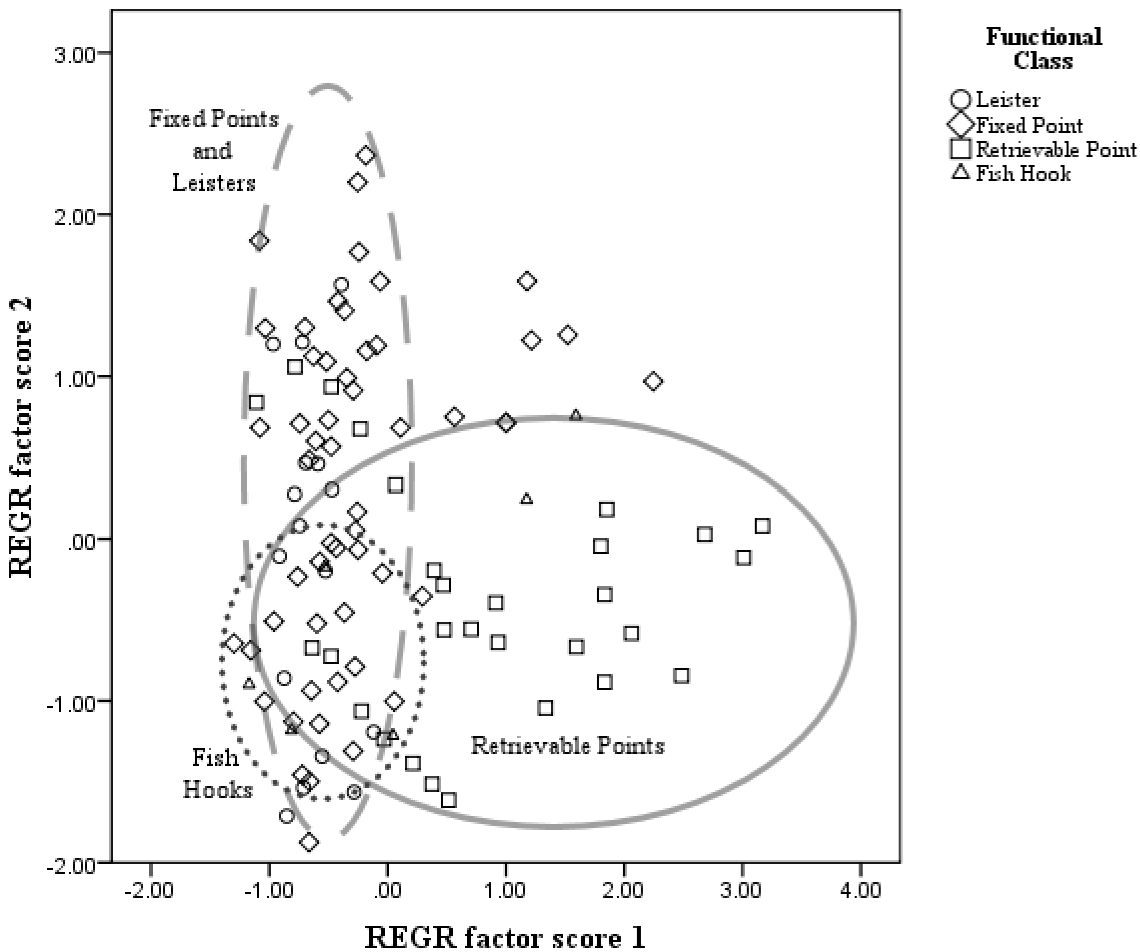


Figure 6.34. Principle Component Analysis Scatter Plot.
The majority of points within each functional class are contained in each ellipse. Outlying points include 7 fixed points, 2 fish hooks, and 4 retrievable points not included within ellipses.

Examination of Fixed Point Functional Subclasses: Barbed Arrows and Barbed Spears

Based on ethnographic data, Carlson (1954:24) hypothesized the importance of barbed point cross-section for determining bird arrows from fish spears. Carlson argued that fixed points with lenticular cross-sections and wedged-shaped bases are barbed spears while those with circular cross-sections and conical bases are barbed arrows. Combining Carlson's (1954) and Clark's (1975) hypotheses, leads to the expectation that bird arrows have circular cross-sections (a high width/thickness index value) and denser barbs.

I examined 115 fixed points for the trends suggested by Carlson and found considerable variation in the cross-sections of points with wedged bases (Figure 6.35). As cross-section was not recorded, maximum projectile width/maximum projectile thickness was used as a proxy. A high ratio value indicates a circular cross-section, while a lower ratio indicates a lenticular cross-section. While metric outliers with high width/thickness index values are present, the mean width/thickness index value of wedged based fixed points is slightly above 0.5 (mean=0.53). Conical bases correspond with higher width/thickness index values (mean=0.65). Two base types not discussed by Carlson, squared and rounded, belong primarily to barbed spears, as their mean index value is approximately 0.5. While there is considerable overlap in index values due to a high degree of morphological variation in fixed points, conical based points have a higher mean width/thickness ratio than other base types. This difference was not significant at a 0.01 level (Table 6.13). While not statistically significant, it is apparent that conical bases tend to have more circular profiles. Based on this sample, Carlson's determination of function based on cross-section and base type appears valid, but more variation is present than he implies.

Based on the results of the principle component analysis, it is apparent that base length negatively covaries with projectile width, and positively covaries with projectile length. This means that fixed points and leisters tend to have longer bases than other barbed point types. Differences in mean base length by functional class were statistically significant (Table 6.13).

While fixed points and leisters have longer bases than other functional classes, the question remained whether the base lengths of points with lenticular profiles were longer than those with circular profiles. To explore this, base length was compared to width and index ratio. A linear relationship was expected between width/thickness index values and base length. This relationship was not detected (Figure 6.36). Although fixed points have longer bases, no negative correlation between base length and width/thickness index was detected. Base length does not appear to covary with cross-section. However, long base lengths are associated with both fixed points and leisters.

No clear pattern of changes in the width/thickness index of fixed points is apparent through time (Figure 6.37). High index values (>0.7), i.e. circular profiles, appear to be most common in the 1000 BP time period. This could be an effect of sample size, or could indicate that the use of fixed points as barbed arrows became more common in that time period.

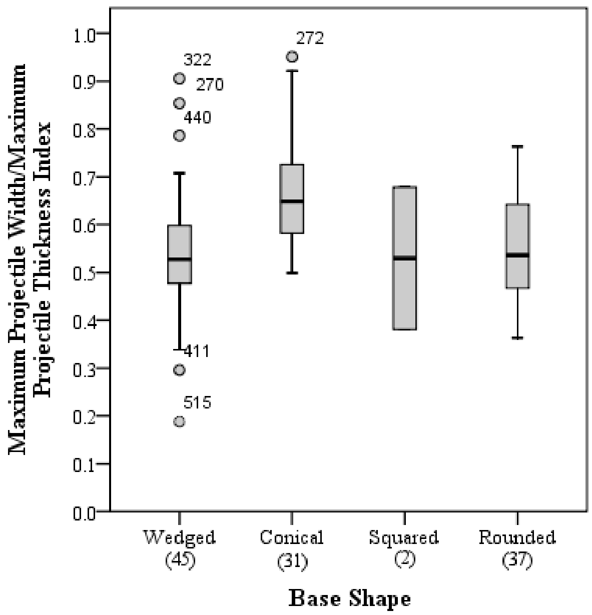


Figure 6.35. Fixed Point Maximum Projectile Width/Maximum Projectile Thickness by Base Type (N=115).

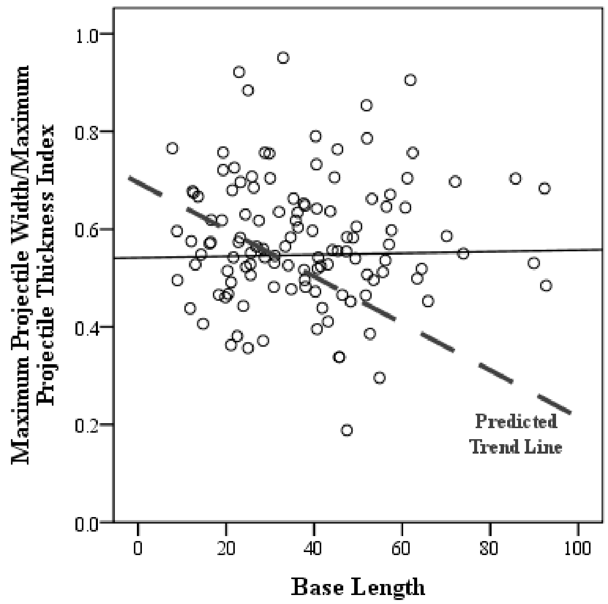


Figure 6.36. Fixed Point Maximum Projectile Width/Maximum Projectile Thickness by Base Length (N=115).

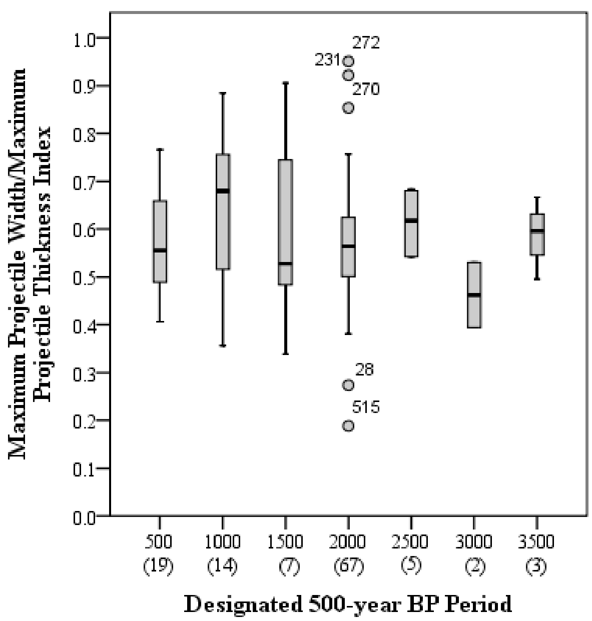


Figure 6.37. Fixed Point Maximum Projectile Width/Maximum Projectile Thickness by 500 year BP Time Period (N=117).

Chronological Variation

Types by 500 year BP Periods

Rank order of functional class counts by time period was examined in order to determine if there were changes in functional class frequencies through time (Figure 6.39, Table 6.22). In general, the rank order of functional types were: fixed points, retrievable points, leisters, and fish hooks. Rank order varied in earlier (3000 BP+) time periods, which may be attributable to small sample sizes. In the 1000, 1500, and 3000 BP time periods retrievable points are more common than fixed points. If these changes in rank order are not an effect of sample size, a notable shift in functional class frequencies occurred during the Marpole period (1500-2500 BP). Fixed points become the most common barbed point type. This change, which corresponds with changes in material usage, may be indicative of major changes in subsistence patterns during this time period. Although I do not have a direct measure, as socketed harpoons were not examined, Northwest Coast archaeologists (e.g. Mitchell 1990) have noted that composite socketed harpoons are more common in late period assemblages. If these are a substitute for tanged harpoons, than this may explain the lower frequency seen in later time periods.

Material Usage by 500 year BP Periods

McMurdo (1972:119) hypothesized that antler would be used more frequently than bone in earlier time periods. In my sample, bone and antler use clearly varies through time (Figure 6.38). In general, antler is utilized less than bone for all points, except during the St. Mungo and Marpole periods.

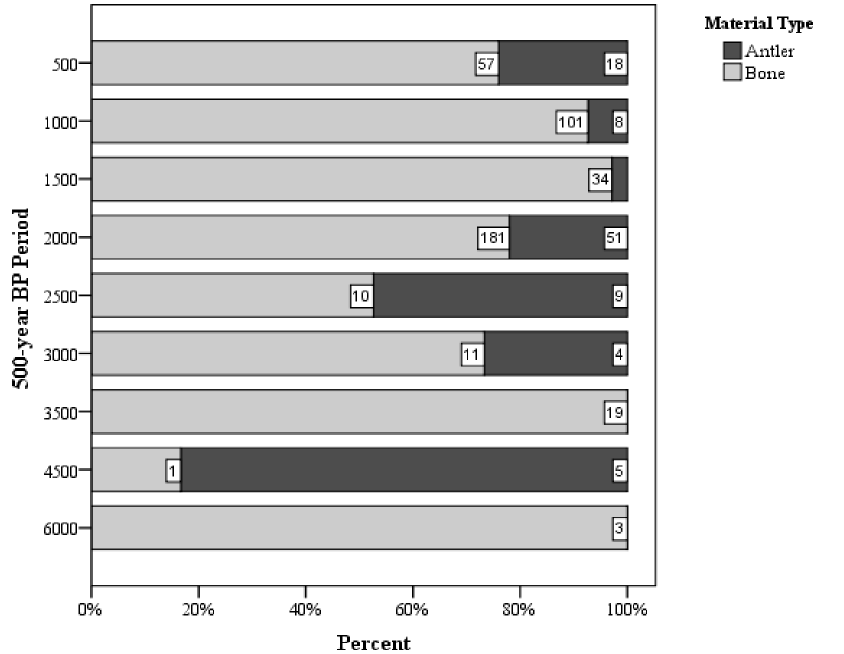


Figure 6.38. Material Type Frequency by 500 year BP Period (N=513).

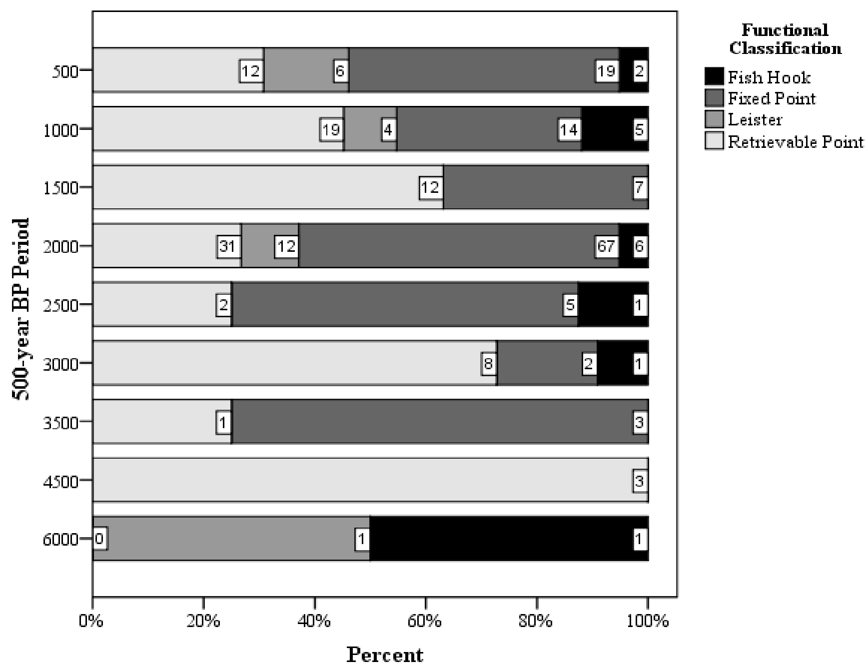


Figure 6.39. Functional Class Frequency by 500 Year BP Time Period (N=244).

Table 6.22. Functional Class by 500-year BP Period.

			500-year BP Period									Total
			500	1000	1500	2000	2500	3000	3500	4500	6000	
Functional Class	Fish Hook	Count (Rank)	2 (4)	5 (3)	0 (3.5)	6 (4)	1 (3)	1 (3)	0 (3.5)	0 (3.5)	1 (1.5)	16
		% within Functional Classification	12.5%	31.2%	.0%	37.5%	6.2%	6.2%	.0%	.0%	6.2%	100.0%
		% within 500-year BP Period	5.1%	11.9%	.0%	5.1%	9%	9%	.0%	.0%	50%	6.5%
	Fixed Point	Count (Rank)	19 (1)	14 (2)	7 (2)	67 (1)	5 (1)	2 (2)	3 (1)	0 (3.5)	0 (3.5)	117
		% within Functional Classification	16.2%	12.0%	6.0%	57.3%	4.3%	1.7%	2.6%	.0%	.0%	100.0%
		% within 500-year BP Period	48.7%	33.3%	36.84%	57.8%	62.5%	18.1%	75%	.0%	.0%	47.95%
	Leister	Count	6 (3)	4 (4)	0 (3.5)	12 (3)	0 (4)	0 (4)	0 (3.5)	0 (3.5)	1 (1.5)	23
		% within Functional Classification	26.1%	17.4%	.0%	52.2%	.0%	.0%	.0%	.0%	4.3%	100.0%
		% within 500-year BP Period	15.38%	9.5%	.0%	10.3%	.0%	.0%	.0%	.0%	50%	9.4%
	Retrievable Point	Count (Rank)	12 (2)	19 (1)	12 (1)	31 (2)	2 (2)	8 (1)	1 (2)	3 (1)	0 (3.5)	88
		% within Functional Classification	13.6%	21.6%	13.6%	35.2%	2.3%	9.1%	1.1%	3.4%	.0%	100.0%
		% within 500-year BP Period	30.7%	42.2%	63.15%	26.72%	18.1%	72.7%	25%	75%	.0%	36%
Total		Count	39	42	19	116	8	11	4	3	2	244
		% within Functional Classification	15.98%	17.21%	7.7%	47.54%	3.27%	4.5%	1.6%	1.2%	.8%	100.0%

Characters by 500 year BP Periods

Shaft barb shape, line attachment type, and base shape were examined for chronological trends. The rank order of shaft barb shape counts (Table 6.23) remain consistent through time from the 2500 BP time period to present, with straight barbs being the most prevalent followed by squared and convex barbs. In time periods before 2500 BP, changes in rank order are attributed to sample size issues. Straight and convex barbs, and all time periods older than 3000 BP were combined for a chi-square test of independence. Shaft barb shape and time period were not independent (Table 6.13). While squared barbs are never ranked higher than straight or convex barbs, there is a gradual increase in their frequency after 2000 BP.

Although ridged shaft barbs do not outrank non-ridged shaft barbs in any time periods, their frequency appears to have a gradual unimodal trend that peaks in the 2000 BP time period (Table 6.24). The rank order of barb silhouette classes reverse at the end of the Marpole period and enclosed barbs become more common (Table 6.25). Shaft barb extension demonstrates no chronological trends, low barbs are most common in all time periods (Table 6.26). Shaft barb ridging was independent of time period, as was shaft barb silhouette (Table 6.13). For the chi-square tests the 3500 BP and earlier time periods were combined. Shaft barb extension was not examined due to low cell values for high barbs.

Table 6.23. Shaft Barb Shape by 500-year BP Period.

			500-year BP Period									Total
			500	1000	1500	2000	2500	3000	3500	4500	6000	
Shaft Barb Shape	Convex	Count (Rank)	2 (3)	1 (3)	1 (3)	2 (3)	1 (3)	1 (3)	0 (3)	0 (2.5)	0 (2.5)	8
		% within Shaft Barb Shape	25.0%	12.5%	12.5%	25.0%	12.5%	12.5%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	3.5%	1.2%	2.9%	1.1%	6.25%	6.25%	.0%	.0%	.0%	2.0%
	Squared	Count (Rank)	20 (2)	35 (2)	10 (2)	34 (2)	3 (2)	9 (1)	3 (2)	3 (1)	0 (2.5)	117
		% within Shaft Barb Shape	17.1%	29.9%	8.5%	29.1%	2.6%	7.7%	2.6%	2.6%	.0%	100.0%
		% within 500-year BP Period	35%	44.87%	38.5%	18.6%	18.75%	56.25%	16.6%	100%	.0%	29.3%
	Straight	Count (Rank)	35 (1)	42 (1)	15 (1)	147 (1)	12 (1)	6 (2)	15 (1)	0 (2.5)	2 (1)	274
		% within Shaft Barb Shape	12.8%	15.3%	5.5%	53.6%	4.4%	2.2%	5.5%	.0%	.7%	100.0%
		% within 500-year BP Period	61.4%	53.84%	57.7%	80.3%	75%	37.5%	83.3%	.0%	100%	68.67%
Total		Count	57	78	26	183	16	16	18	3	2	399
		% within Shaft Barb Shape	14.3%	19.5%	6.5%	45.9%	4.0%	4.0%	4.5%	0.75%	.5%	100.0%

Table 6.24. Presence/Absence of Ridged Shaft Barbs by 500-year BP Period.

			500-year BP Period									Total
			500	1000	1500	2000	2500	3000	3500	4500	6000	
Ridged Shaft Barbs	Absent	Count (Rank)	44 (1)	63 (1)	17 (1)	101 (1)	10 (1)	7 (1)	13 (1)	3 (1)	1 (1.5)	259
		% within Ridged Shaft Barbs	17.0%	24.3%	6.6%	39.0%	3.9%	2.7%	5.0%	1.2%	.4%	100.0%
		% within 500-year BP Period	74.6%	76.8%	65.4%	55.8%	62.5%	63.6%	76.5%	100.0%	50.0%	65.2%
	Present	Count (Rank)	15 (2)	19 (2)	9 (2)	80 (2)	6 (2)	4 (2)	4 (2)	0 (2)	1 (1.5)	138
		% within Ridged Shaft Barbs	10.9%	13.8%	6.5%	58.0%	4.3%	2.9%	2.9%	.0%	.7%	100.0%
		% within 500-year BP Period	25.4%	23.2%	34.6%	44.2%	37.5%	36.4%	23.5%	.0%	50.0%	34.8%
Total		Count	59	82	26	181	16	11	17	3	2	397
		% within Ridged Shaft Barbs	14.9%	20.7%	6.5%	45.6%	4.0%	2.8%	4.3%	.8%	.5%	100.0%

Table 6.25. Shaft Barb Silhouette by 500-year BP Period.

			500-year BP Period									Total
			500	1000	1500	2000	2500	3000	3500	4500	6000	
Shaft Barb Silhouette	Enclosed	Count (Rank)	25 (2)	43 (1)	18 (1)	82 (2)	3 (2)	4 (2)	8 (2)	1 (2)	0 (2)	184
		% within Shaft Barb Silhouette	13.6%	23.4%	9.8%	44.6%	1.6%	2.2%	4.3%	.5%	.0%	100.0%
		% within 500-year BP Period	36.2%	52.4%	69.2%	45.5%	18.8%	36.4%	47.1%	33.3%	.0%	46.46%
	Extended	Count (Rank)	34 (1)	39 (2)	8 (2)	98 (1)	13 (1)	7 (1)	9 (1)	2 (1)	2 (1)	212
		% within Shaft Barb Silhouette	16.0%	18.4%	3.8%	46.2%	6.1%	3.3%	4.2%	.9%	.9%	100.0%
		% within 500-year BP Period	49.3%	47.5%	30.7%	54.4%	81.3%	63.6%	52.9%	66.6%	100.0%	53.53%
Total		Count	69	82	26	180	16	11	17	3	2	396
		% within Shaft Barb Silhouette	17.4%	20.7%	6.5%	45.5%	4%	2.7%	4.3%	0.7%	0.5%	100.0%

Table 6.26. Shaft Barb Extension by 500-year BP Period.

			500-year BP Period									Total
			500	1000	1500	2000	2500	3000	3500	4500	6000	
Shaft Barb Extension	High	Count (Rank)	2 (2)	4 (2)	3 (2)	17 (2)	3 (2)	2 (2)	1 (2)	0 (2)	0 (2)	32
		% within Shaft Barb Extension	6.2%	12.5%	9.4%	53.1%	9.4%	6.2%	3.1%	.0%	.0%	100.0%
		% within 500-year BP Period	3.3%	4.9%	11.5%	9.4%	20%	18.2%	5.9%	.0%	.0%	8.1%
	Low	Count (Rank)	57 (1)	78 (1)	23 (1)	163 (1)	12 (1)	9 (1)	16 (1)	3 (1)	2 (1)	363
		% within Shaft Barb Extension	15.7%	21.5%	6.3%	44.9%	3.3%	2.5%	4.4%	.8%	.6%	100.0%
		% within 500-year BP Period	96.6%	95.1%	88.5%	90.6%	80.0%	81.8%	94.1%	100.0%	100.0%	91.9%
Total		Count	59	82	26	180	15	11	17	3	2	395
		% within Shaft Barb Extension	14.9%	20.8%	6.6%	45.6%	3.8%	2.8%	4.3%	0.7%	0.5%	100.0%

Despite the small sample size of barbed points older than 2500 BP, there is a trend from bilateral barb application towards unilateral barb application through time with unilateral barb application appearing approximately 3000 BP at the start of the Locarno Beach period. This fits with the general trends discussed by Bennyhoff (1950) who noted a similar transition in Californian fish spears and harpoons and suggested that this was a general trend in barbed points from the North American Pacific Coast.

Issues of sample size in time periods before 2500 BP also apply when examining changes in shaft barb paradigmatic classes (Table 6.27, see Table 5.3 for class definitions) as strong chronological trends in the combinations of these characters were not detected. The most common classes (ACTCT, ACACT, TCTGT, ACAGT) maintained rank order through time, with deviations in other classes through time being attributable to sample size. Chi-square tests were not used, due to low expected values in the majority of cells. While not shown, head barbs follow the same pattern as shaft barbs, demonstrating consistency through time in rank order until 2500 BP when the sample size becomes too small for reliable inferences. This indicates that all barb styles may be well established in the Gulf of Georgia by 2500 BP or earlier.

Although the sample size of dated points with microbarbs is small (N=64), the rank order of microbarbs remained consistent through time (Table 6.28), with the exception of 1500 BP where grooved microbarbs were more common than notched. Microbarb type and time period are independent (Table 6.13). All time periods 2000 BP or older were combined for this test. Both types of microbarbs are present in all time periods after 2000 BP. Based on

Table 6.27. Shaft Barb Paradigmatic Class by 500-year BP Period.

			500-year BP Period									Total
			500	1000	1500	2000	2500	3000	3500	4500	6000	
Barb Paradigmatic Class	ACACA	Count (Rank)	0 (19)	1 (15)	0 (19.5)	3 (14)	0 (15.3)	1 (7)	0 (14.8)	0 (13)	0 (13)	5
		% within Barb Paradigmatic Class	.0%	20.0%	.0%	60.0%	.0%	20.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	1.3%	.0%	1.6%	.0%	6.25%	.0%	.0%	.0%	1.25%
	ACACT	Count (Rank)	9 (2)	7 (4.5)	0 (19.5)	30 (2)	5 (1)	0 (18.4)	2 (4.5)	0 (13)	1 (1.5)	54
		% within Barb Paradigmatic Class	16.7%	13.0%	.0%	55.6%	9.3%	.0%	3.7%	.0%	1.9%	100.0%
		% within 500-year BP Period	15.8%	9%	.0%	16.3%	31.25%	.0%	11.1%	.0%	50.0%	13.5%
	ACAGA	Count (Rank)	1 (13.5)	1 (15)	0 (19.5)	2 (16.5)	0 (15.3)	0 (18.4)	0 (14.8)	0 (13)	0 (13)	4
		% within Barb Paradigmatic Class	25.0%	25.0%	.0%	50.0%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	1.8%	1.3%	.0%	1.1%	.0%	.0%	.0%	.0%	.0%	1%
	ACAGT	Count (Rank)	2 (11)	4 (8.5)	3 (3.5)	27 (3)	0 (15.3)	1 (7)	0 (14.8)	0 (13)	0 (13)	37
		% within Barb Paradigmatic Class	5.4%	10.8%	8.1%	73.0%	.0%	2.7%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	3.5%	5.1%	11.5%	14.7%	.0%	6.25%	.0%	.0%	.0%	9.25%
	ACTCA	Count (Rank)	2 (11)	4 (8.5)	0 (19.5)	8 (8.5)	0 (15.3)	0 (18.4)	0 (14.8)	0 (13)	0 (13)	14
		% within Barb Paradigmatic Class	14.3%	28.6%	.0%	57.1%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	3.5%	5.1%	.0%	4.3%	.0%	.0%	.0%	.0%	.0%	3.5%
	ACTCT	Count (Rank)	13 (1)	10 (2.5)	3 (3.5)	32 (1)	4 (2)	3 (2)	7 (1)	0 (13)	1 (1.5)	73
		% within Barb Paradigmatic Class	17.8%	13.7%	4.1%	43.8%	5.5%	4.1%	9.6%	.0%	1.4%	100.0%
		% within 500-year BP Period	22.8%	12.8%	11.5%	17.4%	25%	18.75%	38.8%	.0%	50%	18.25%
	ACTGA	Count (Rank)	1 (13.5)	0 (20.5)	1 (8)	5 (12.5)	0 (15.3)	0 (18.4)	0 (14.8)	0 (13)	0 (13)	7
		% within Barb Paradigmatic Class	14.3%	.0%	14.3%	71.4%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	1.8%	.0%	3.8%	2.7%	.0%	.0%	.0%	.0%	.0%	1.75%
	ACTGT	Count (Rank)	3 (7)	5 (6.5)	1 (8)	12 (5)	1 (6)	0 (18.4)	4 (2)	0 (13)	0 (13)	26
		% within Barb Paradigmatic Class	11.5%	19.2%	3.8%	46.2%	3.8%	.0%	15.4%	.0%	.0%	100.0%
		% within 500-year BP Period	5.20%	6.4%	3.8%	6.5%	6.25%	.0%	22.2%	.0%	.0%	6.5%

			500-year BP Period									Total
			500	1000	1500	2000	2500	3000	3500	4500	6000	
Barb Paradigmatic Class	AGACA	Count (Rank)	0 (19)	0 (20.5)	1 (8)	0 (22)	0 (15.3)	0 (18.4)	0 (14.8)	0 (13)	0 (13)	1
		% within Barb Paradigmatic Class	.0%	.0%	100.0%	.0%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	.0%	3.8%	.0%	.0%	.0%	.0%	.0%	.0%	.25%
	AGACT	Count (Rank)	0 (19)	2 (12)	1 (8)	9 (6.5)	2 (3)	1 (7)	0 (14.8)	0 (13)	0 (13)	15
		% within Barb Paradigmatic Class	.0%	13.3%	6.7%	60.0%	13.3%	6.7%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	2.6%	3.8%	4.9%	12.5%	6.25%	.0%	.0%	.0%	3.75%
	AGAGT	Count (Rank)	3 (7)	5 (6.5)	4 (2)	9 (6.5)	0 (15.3)	0 (18.4)	2 (4.5)	0 (13)	0 (13)	23
		% within Barb Paradigmatic Class	13.0%	21.7%	17.4%	39.1%	.0%	.0%	8.7%	.0%	.0%	100.0%
		% within 500-year BP Period	5.20%	6.4%	15.4%	4.9%	.0%	.0%	11.1%	.0%	.0%	5.75%
	AGTCT	Count (Rank)	3 (7)	1 (15)	1 (8)	6 (11)	1 (6)	1 (7)	0 (14.8)	0 (13)	0 (13)	13
		% within Barb Paradigmatic Class	23.1%	7.7%	7.7%	46.2%	7.7%	7.7%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	5.20%	1.3%	3.8%	3.3%	6.25%	6.25%	.0%	.0%	.0%	3.2%
	AGTGA	Count (Rank)	0 (19)	0 (20.5)	1 (8)	1 (19.5)	0 (15.3)	0 (18.4)	0 (14.8)	0 (13)	0 (13)	2
		% within Barb Paradigmatic Class	.0%	.0%	50.0%	50.0%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	.0%	3.8%	.5%	.0%	.0%	.0%	.0%	.0%	.5%
	AGTGT	Count (Rank)	0 (19)	3 (10.5)	0 (19.5)	5 (12.5)	0 (15.3)	0 (18.4)	0 (14.8)	0 (13)	0 (13)	8
		% within Barb Paradigmatic Class	.0%	37.5%	.0%	62.5%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	3.8%	.0%	2.7%	.0%	.0%	.0%	.0%	.0%	2%
	TCAGT	Count (Rank)	0 (19)	0 (20.5)	0 (19.5)	0 (22)	0 (15.3)	1 (7)	0 (14.8)	0 (13)	0 (13)	1
		% within Barb Paradigmatic Class	.0%	.0%	.0%	.0%	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	.0%	.0%	.0%	.0%	6.25%	.0%	.0%	.0%	.25%
	TCTCA	Count (Rank)	0 (19)	1 (15)	1 (8)	2 (16.5)	0 (15.3)	1 (7)	0 (14.8)	0 (13)	0 (13)	5
		% within Barb Paradigmatic Class	.0%	20.0%	20.0%	40.0%	.0%	20.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	1.3%	3.8%	1%	.0%	6.25%	.0%	.0%	.0%	1.25%

Table 6.28. Microbarb Type by 500-year BP Period.

			500-year BP Period					Total
			500	1000	1500	2000	2500+	
Microbarb Type	Grooved	Count (Rank)	3 (2)	7 (2)	5 (1)	13 (2)	2 (1.5)	30
		% within Microbarb Type	10.0%	23.3%	16.6%	43.3%	6.6%	100.0%
		% within 500-year BP Period	33.30%	46.6%	71.4%	44.8%	44.4%	20.3%
	Notched	Count (Rank)	6 (1)	8 (1)	2 (2)	16 (1)	2 (1.5)	34
		% within Base Shape	17.64%	23.5%	5.8%	47.0%	5.9%	100.0%
		% within 500-year BP Period	66%	53.3%	28.5%	55.2%	50%	2.35%
Total		Count	9	15	7	29	4	64
		% within Base Shape	16.0%	16.0%	7.5%	48.5%	4.2%	100.0%

this data, the hypothesis that notched microbarbs would give way to grooved microbarbs through time appears to be incorrect. The rarity of microbarbs before 2000 BP may be attributed to small sample sizes from these early periods and does not confirm the hypothesis that microbarbs either first appear or increase in frequency as the 'Developed Northwest Coast Pattern' emerges. Only nine artifacts had parallel barb grooves, and this character was absent from all barbed points older than 2000 BP, however as in the case of microbarbs, this may be a function of small sample size.

Line attachment types exhibit chronological variation (Table 6.29), similar to the findings of Bennyhoff (1950) and McMurdo (1972). Bilateral shoulders are the most common line attachment type at 4500 BP. From 3000-1500 BP other forms of bilateral line attachment are introduced. Unilateral line guards and unilateral shoulders also appear at 2000 BP in relatively high concentrations. Bilateral line attachments, save for bilateral notching, disappear by 1000 BP. In general, the earliest periods fit the pattern recorded by Bennyhoff with Californian barbed spears and harpoons. Similarly, the line attachment types seen during the Marpole period fit McMurdo's observations.

Base shape shows variation in rank order through time (Table 6.30). The most significant change is a transition in the rank order of wedged bases and rounded bases around 1500 BP, when rounded bases are more common. These are the two most common base types, and are typical of both fixed and retrievable points. This apparent transition could be an effect of small sample sizes in time periods prior to 2500 BP, or may indicate a change in base styles through time. Another possibility is that there are functional differences between these base types. This could be investigated with experimental approaches. The rank order of conical and squared bases, however, remains relatively consistent through time at third and fourth respectively. Flanged and squared bases are not present in all time periods, due, most likely, to their relative rarity in general and to small sample sizes from earlier periods. Chi-square tests were not performed for either line attachment type by time period or base type by time period due to the low expected values in the majority of cells. Combining characters to achieve larger cell values did not seem appropriate as analytic meaning would be lost.

Table 6.29. Line Attachment Type by 500-year BP Period.

			500-year BP Period								Total
			500	1000	1500	2000	2500	3000	3500	4500	
Line Attachment Type	Bilateral Line Guard	Count (Rank)	0 (8)	0 (9.5)	1 (5)	3 (4)	0 (7)	1 (4.5)	0 (6.5)	0 (7)	5
		% within Line Attachment Type	.0%	.0%	20.0%	60.0%	.0%	20.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	.0%	8.3%	9.6%	.0%	12.50%	.0%	.0%	5.7%
	Bilateral Notching	Count (Rank)	1 (4.5)	3 (3)	0 (9)	1 (8.5)	0 (7)	0 (8.5)	0 (6.5)	0 (7)	5
		% within Line Attachment Type	20.0%	60.0%	.0%	20.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	8.3%	16.6%	.0%	3.2%	.0%	.0%	.0%	.0%	5.7%
	Bilateral Shoulder	Count (Rank)	0 (8)	0 (9.5)	1 (5)	2 (6)	1 (1.5)	2 (2)	0 (6.5)	2 (1)	8
		% within Line Attachment Type	.0%	.0%	12.5%	25.0%	12.5%	25.0%	.0%	25.0%	100.0%
		% within 500-year BP Period	.0%	.0%	8.3%	6.4%	50%	25.00%	.0%	66.6%	9.2%
	Combination Line Hole	Count (Rank)	0 (8)	2 (4)	1 (5)	0 (10.5)	0 (7)	1 (4.5)	0 (6.5)	0 (7)	4
		% within Line Attachment Type	.0%	50.0%	25.0%	.0%	.0%	25.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	11.1%	8.3%	.0%	.0%	12.50%	.0%	.0%	.8%
	Constriction	Count (Rank)	2 (3)	0 (9.5)	0 (9)	2 (6)	0 (7)	0 (8.5)	0 (6.5)	0 (7)	4
		% within Line Attachment Type	50.0%	.0%	.0%	50.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	16.6%	.0%	.0%	6.4%	.0%	.0%	.0%	.0%	4.6%

			500-year BP Period								Total
			500	1000	1500	2000	2500	3000	3500	4500	
Line Attachment Type	Drilled Line Hole	Count (Rank)	0 (8)	1 (6)	0 (9)	5 (2.5)	0 (7)	0 (8.5)	1 (1)	0 (7)	7
		% within Line Attachment Type	.0%	14.3%	.0%	71.4%	.0%	.0%	14.3%	.0%	100.0%
		% within 500-year BP Period	.0%	5.5%	.0%	16.1%	.0%	.0%	100.00%	.0%	8%
	Gouged Line Hole	Count (Rank)	1 (4.5)	0 (9.5)	0 (9)	0 (10.5)	0 (7)	0 (8.5)	0 (6.5)	0 (7)	1
		% within Line Attachment Type	100.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	8.3%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.1%
	Reverse Barb	Count (Rank)	0 (8)	1 (6)	0 (9)	1 (8.5)	0 (7)	0 (8.5)	0 (6.5)	0 (7)	2
		% within Line Attachment Type	.0%	50.0%	.0%	50.0%	.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	5.5%	.0%	3.2%	.0%	.0%	.0%	.0%	2.3%
	Unilateral Line Guard	Count (Rank)	4 (1.5)	1 (6)	2 (3)	10 (1)	0 (7)	2 (2)	0 (6.5)	0 (7)	19
		% within Line Attachment Type	21.1%	5.3%	10.5%	52.6%	.0%	10.5%	.0%	.0%	100.0%
		% within 500-year BP Period	33.3%	5.5%	16.6%	32.25%	.0%	25.00%	.0%	.0%	21.9%
	Unilateral Notching	Count (Rank)	0 (8)	5 (1.5)	3 (2)	2 (6)	1 (1.5)	2 (2)	0 (6.5)	0 (7)	13
		% within Line Attachment Type	.0%	38.5%	23.1%	15.4%	7.7%	15.4%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	27.7%	25%	6.4%	50%	25.00%	.0%	.0%	14.9%

			500-year BP Period								Total
			500	1000	1500	2000	2500	3000	3500	4500	
	Unilateral Shoulder	Count (Rank)	4 (1.5)	5 (1.5)	4 (1)	5 (2.5)	0 (7)	0 (8.5)	0 (6.5)	1 (2)	19
		% within Line Attachment Type	21.1%	26.3%	21.1%	26.3%	.0%	.0%	.0%	33.30%	100.0%
		% within 500-year BP Period	33.3%	27.7%	33.3%	16.1%	.0%	.0%	.0%	16.7%	21.8%
Total		Count	12	18	12	31	2	8	1	3	87
		% within Line Attachment Type	13.8%	20.6%	13.8%	35.6%	3.7%	2.3%	1.1%	3.4%	100.0%

Table 6.30. Base Shape by 500-year BP Period.

			500-year BP Period									Total
			500	1000	1500	2000	2500	3000	3500	4500	6000	
Base Shape	Conical	Count (Rank)	6 (3)	7 (3)	2 (4)	23 (3)	4 (1.5)	0 (5)	1 (2)	0 (3.5)	0 (3.5)	43
		% within Base Shape	14.0%	16.3%	4.7%	53.5%	9.3%	.0%	2.3%	.0%	.0%	100.0%
		% within 500-year BP Period	17.6%	20.5%	12.5%	22.3%	44.4%	.0%	33.3%	.0%	.0%	20.3%
	Flanged	Count (Rank)	0 (4.5)	0 (4.5)	0 (5)	4 (4.5)	0 (4.5)	1 (3.5)	0 (4)	0 (3.5)	0 (3.5)	5
		% within Base Shape	.0%	.0%	.0%	80.0%	.0%	10.0%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	.0%	.0%	3.8%	.0%	4.5%	.0%	.0%	.0%	2.35%
	Rounded	Count (Rank)	16 (1)	15 (1)	5 (1)	32 (2)	1 (3)	3 (2)	0 (4)	0 (3.5)	1 (1)	73
		% within Base Shape	21.9%	20.5%	6.8%	43.8%	11.1%	4.1%	.0%	.0%	1.4%	100.0%
		% within 500-year BP Period	47.0%	44.1%	31.25%	31.1%	5.3%	30%	.0%	.0%	100%	34.4%
	Squared	Count (Rank)	0 (4.5)	0 (4.5)	4 (3)	4 (4.5)	0 (4.5)	1 (3.5)	0 (4)	0 (3.5)	0 (3.5)	9
		% within Base Shape	.0%	.0%	44.4%	44.4%	.0%	10%	.0%	.0%	.0%	100.0%
		% within 500-year BP Period	.0%	.0%	25%	3.8%	.0%	4.5%	.0%	.0%	.0%	4.24%
	Wedged	Count (Rank)	11 (2)	12 (2)	5 (2)	40 (1)	4 (1.5)	5 (1)	2 (1)	3 (1)	0 (3.5)	82
		% within Base Shape	13.4%	14.6%	6.1%	48.8%	4.9%	6.1%	2.4%	3.7%	.0%	100.0%
		% within 500-year BP Period	32.35%	35.3%	31.25%	38.8%	44.4%	50%	66.6%	100%	.0%	38.67%
Total		Count	34	34	16	103	9	10	3	3	1	212
		% within Base Shape	16.0%	16.0%	7.5%	48.5%	4.2%	4.7%	1.4%	1.4%	.5%	100.0%

Summary

Results for the hypotheses presented in Tables 6.1 and 6.2 are provided in Tables 6.31 and 6.32. The chronological trends discussed by McMurdo (1972:119-122) and Bennyhoff (1950) in their analyses were replicated in this sample. This data also demonstrated patterns consistent with Carlson's (1954:24) functional classes for fixed points. Many barbed point attributes such as projectile length, width, head barb width, head barb angle, barb density, and base type vary by functional class and should therefore be subject to strong functional pressures. In order to avoid detecting a false phylogenetic signal due to functional convergence, head barbs, barb application, and barb frequency will not be used in the cladistics analysis. While barbs have an overall functional purpose, I argue that the variation in traits such as shaft barb shape (Table 6.14), silhouette (Table 6.15), extension (Table 6.16), and microbarb type (Table 6.17) is stylistic in nature. These traits will be used accordingly in the cladistics analyses.

Table 6.31. Results of Functional and Stylistic Variation Analyses.

Question	Supported Hypothesis (H0 or HA)	Tests	Result
Are there manufacturing or functional constraints on Attributes?	HA: There are distinct metric differences between functional classes as defined by Table 2.1.	Figures 6.22, 6.23, 6.34 Tables 6.13, 6.21	Retrievable points are generally wider, while fish hooks are shorter in length.
	HA: Material use varies by functional class.	Figure 6.21	Antler is a more commonly used material for retrievable points than other types.
	H0: Barb morphology does not vary by functional class.	Figure 6.30 Tables 6.13, 14, 6.15, 6.16, 6.17, 6.18	Barb morphological attributes appear in similar frequencies for all functional classes.
	HA: Head barb morphology demonstrates less morphological variation than shaft barb morphology due to functional constraints.	Figures 6.26, 6.27, 6.34 Tables 6.13, 6.21	The head barbs of retrievable points are wider than other functional types, and the head barb angles of retrievable points vary less than other types. Compared to shaft barbs, it appears that at least for retrievable points head barbs have functional constraints.
Are there testable distinctions between functional subtypes of fixed Points?	HA: Fixed point profile corresponds with base types.	Figure 6.35	While not a statistically significant difference, conical bases tend to correspond with circular profiles, while other base types tend to correspond with lenticular profiles.
	HA: Fixed point barb density corresponds with projectile profile.	Figure 6.31 Table 6.13	While not a statistically significant difference, fixed points with dense barbs tend to have more circular profiles while leisters and retrievable points with dense barbs tend to have more lenticular profiles.
	H0: Fixed point hafting size does not correspond with projectile profile.	Figure 6.36 Table 6.13	There was no trend between points with more lenticular profiles having longer bases.

Table 6.32. Results of Chronological Variation Analyses.

Question	HA(H0)	Tests	Result
Do barbed point functions change through time?	HA: The relative frequencies of functional classes, as defined in Table 2.1, vary by time period.	Figure 6.39 Table 6.22	Fixed points become more common than retrievable points from 1500-2500 BP, the Marpole period.
	HA: The use of antler as a material increases from 1500-2500 BP.	Figure 6.38	There is a relative increase in the use of antler from 1500-2500 BP, corresponding with the Marpole period.
	HA: There is a transition to bilateral line attachment types during the Marpole phase.	Table 6.29	Bilateral line attachment types are re-introduced during the Marpole period, and are absent from the Gulf of Georgia phase save for bilateral notching.
	HA: There is a transition from bilateral to unilateral line attachments at the beginning of the Locarno Beach phase, corresponding with a general trend in North American Pacific Coast barbed point morphology during this period.	Table 6.29	There appears to be a general transition from bilateral barb application and bilateral line attachments to unilateral barb application and unilateral line attachments at the start of the Locarno Beach period.
Do barbed point individual identity markers emerge through time?	H0: Ridged barbs and microbarbs do not first appear after 2000 BP.	Tables 6.13, 6.24, 6.27	Microbarbs are found in earlier time periods, though they appear to increase in frequency in the sample after 2000 BP. Ridged barbs appear to increase in frequency during the Marpole period, however the changes in the frequency of ridged barbs through time was not found to be statistically significant.
	H0: There is not a transition from notched to grooved microbarbs through time.	Table 6.27	Notched and grooved microbarbs maintain similar proportions through most time periods, no long term trends were apparent.
	HA: Barb morphology, excluding ridged barbs and microbarbs, does not vary by time period.	Tables 6.13 6.23, 6.25, 6.26	Barb extension is similar in all time periods with sufficient sample size. While enclosed barbs appear to become more common through time, the changes in the relative frequencies of shaft barb silhouette types were not found to be statistically significant. Squared barbs appear to gradually increase in frequency over the past 2000 years.

Cluster Analysis

Cluster analyses were employed to investigate changes in the stylistic and functional attributes of barbed points between Gulf of Georgia cultural periods. Six cluster analyses were run; divided by period (Gulf of Georgia, Marpole, and Locarno Beach) and whether attributes were considered functional or stylistic in nature. The geographic boundaries of the resulting clusters were examined based on the presence or absence of a given assemblage within a cluster. Functional attributes were predicted to result in broadly spread clusters in all time periods due to the expectation that barbed points shared similar functional constraints. Stylistic attributes were predicted to have more geographically localized clusters in later time periods as a result of conservative cultural transmission.

These analyses utilized mixed nominal, interval-ratio, and binary data. Clustan was used due to its ability to handle mixed data (Wishart 2002). All cases and variables were unweighted, and case-wise deletion was used on missing data. All data was standardized to Z-scores, and squared euclidean distance was used as the distance measure. Clustan's cluster keys feature was used in each analysis to examine which characters determined clusters.

Chronological Assignments

The Gulf of Georgia period analysis consisted of artifacts dating from the 0-500, 500-1000, and 1000-1500 BP time periods. The Marpole period analysis contained artifacts from the 1500-2000 and 2000-2500 BP time periods. For the Locarno Beach period analysis, artifacts from the 2500-3000 BP and 3000-3500 time periods were included. Artifacts from geographically outlying sites were omitted from this analysis.

Attributes Examined

Functional attributes were chosen based on their variation by functional class in the previous analyses. Projectile length, projectile width, projectile thickness, the presence or absence of a curved profile, barb application, head barb metric characters (length, width, maximum barb width, barb angle), shaft barb frequency, presence or absence of a line attachment, and base attributes (width, length, shape, and asymmetry) were all selected as functional attributes. Stylistic attributes, defined as not varying by functional class, included microbarb type, shaft barb angle, shaft barb morphological attributes (shape, extension, silhouette) and line attachment type. McMurdo (1972:114) argued that various forms of line attachment were functionally equivalent. Thus line attachment type has been included as a stylistic attribute, while the presence or absence of a line attachment was included as a functional attribute. Shaft barb frequency was not included as stylistic due to the results of previous analyses which indicate that it may be an attribute influenced by point function (Figure 6.31).

Attributes Determining Clusters

There was considerable continuity in the attributes which determined clusters throughout all time periods in both the functional and stylistic analyses. For the functional analyses, maximum projectile width was the primary attribute, followed by the presence or absence of a curved profile, and finally base width. Both projectile width (Figure 6.23) and base width (Figure 6.33) are tied to functional classes while curved profile is part of the definition for leister. These attributes divide retrievable points and leisters from fixed points and fish hooks, meaning that the clusters roughly correspond with functional classes.

Primary determining attributes for the stylistic clusters included the presence or absence of ridged shaft barbs, microbarb type, shaft barb angle. The division in shaft barb angles roughly corresponds with the difference between squared and straight or convex barbs. Barb extension and silhouette did not play a major role in the formation of clusters.

Geographic Distributions of Stylistic Attribute Clusters

Both the Gulf of Georgia (Figure 6.40, 6.41) and Marpole (Figure 6.42, 6.43) period stylistic cluster analyses lacked clusters limited to specific geographic areas, with one notable exception. In the cluster analysis examining Gulf of Georgia period stylistic attributes (Figure 6.41), Cluster 3 is the most limited in geographic scope and consists of barbed points with both ridged barbs and microbarbs present. While ridged barbs or microbarbs are found throughout the region, areas where a combination of both attributes is present may be more limited in geographic scope during the Gulf of Georgia period. Although the Locarno Beach (Figure 6.44, 6.45) period cluster analysis does appear to have distinct geographic clustering, this is likely due to small sample sizes. While the widespread geographic distribution of clusters was an expected result for the functional attributes, indicating similar functional types as present throughout the Gulf of Georgia, these results indicate that attributes such as ridged barbs, microbarbs, and barb angle were also present throughout the region in all time periods. Barb angle, I argue, serves as a proxy for barb shape and these results indicate that

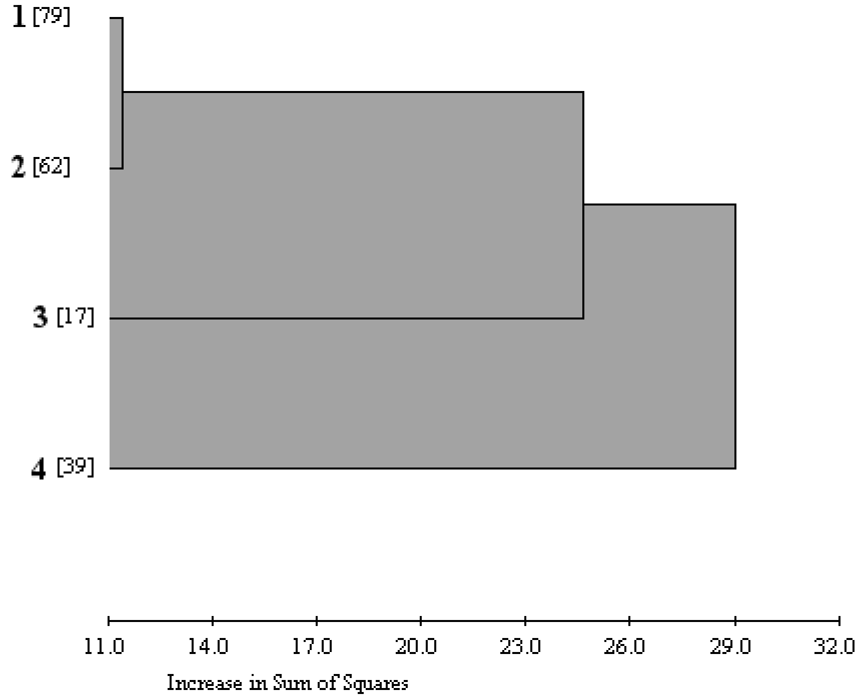


Figure 6.40. Cluster Analysis of Gulf of Georgia Period Barbed Point Stylistic Attributes.

Member Sites and Cases Per Cluster:

Cluster 1: [45IS31b, 45IS7, 45SJ24, 45SJ25, 45SK37, 45SK59a, 45SK7, 45WH17, DcRt10, DcRt15, DcRt16, DcRu12, DcRu2, DcRu78, DdRu4, DgRw4] 5 8 44 47 49 53 57 61 63 64 68 71 74 80 82 89 109 111 112 113 115 117 118 119 120 132 179 181 204 205 245 249 275 276 279 280 281 282 286 299 302 304 305 307 314 317 320 321 322 337 340 343 344 345 348 351 353 356 358 360 383 384 389 390 391 395 398 399 400 403 404 406 408 443 458 465 473 483 485

Cluster 2: [45IS31b, 45IS7, 45SJ105B, 45SJ186, 45SJ24, 45SK59a, 45SK7, 45WH17, DcRt10, DcRt16, DcRu12, DcRu2, DdRu4, DfRu8, DgRw4] 6 7 10 38 39 43 45 48 50 52 54 56 58 60 62 65 66 67 72 73 77 78 79 81 83 84 86 114 116 124 126 127 128 130 131 180 188 202 203 272 273 278 283 301 303 308 313 319 323 324 339 352 357 385 388 393 396 397 402 440 453 490

Cluster 3: [45SJ105A, 45SJ24, 45SK37, 45SK59a, DcRt16, DcRu12, DcRu2, DcRu78, DdRt6] 37 46 70 108 122 123 125 277 306 311 315 334 350 355 359 378 379

Cluster 4: [45IS7, 45SJ24, 45SK59a, DcRt16, DcRu12, DcRu2, DdRu4, DeRv107, DgRw4] 9 51 55 59 69 75 76 85 87 88 121 129 274 284 285 309 310 312 316 318 326 335 336 341 349 386 387 392 394 401 405 407 437 454 456 459 464 467 497

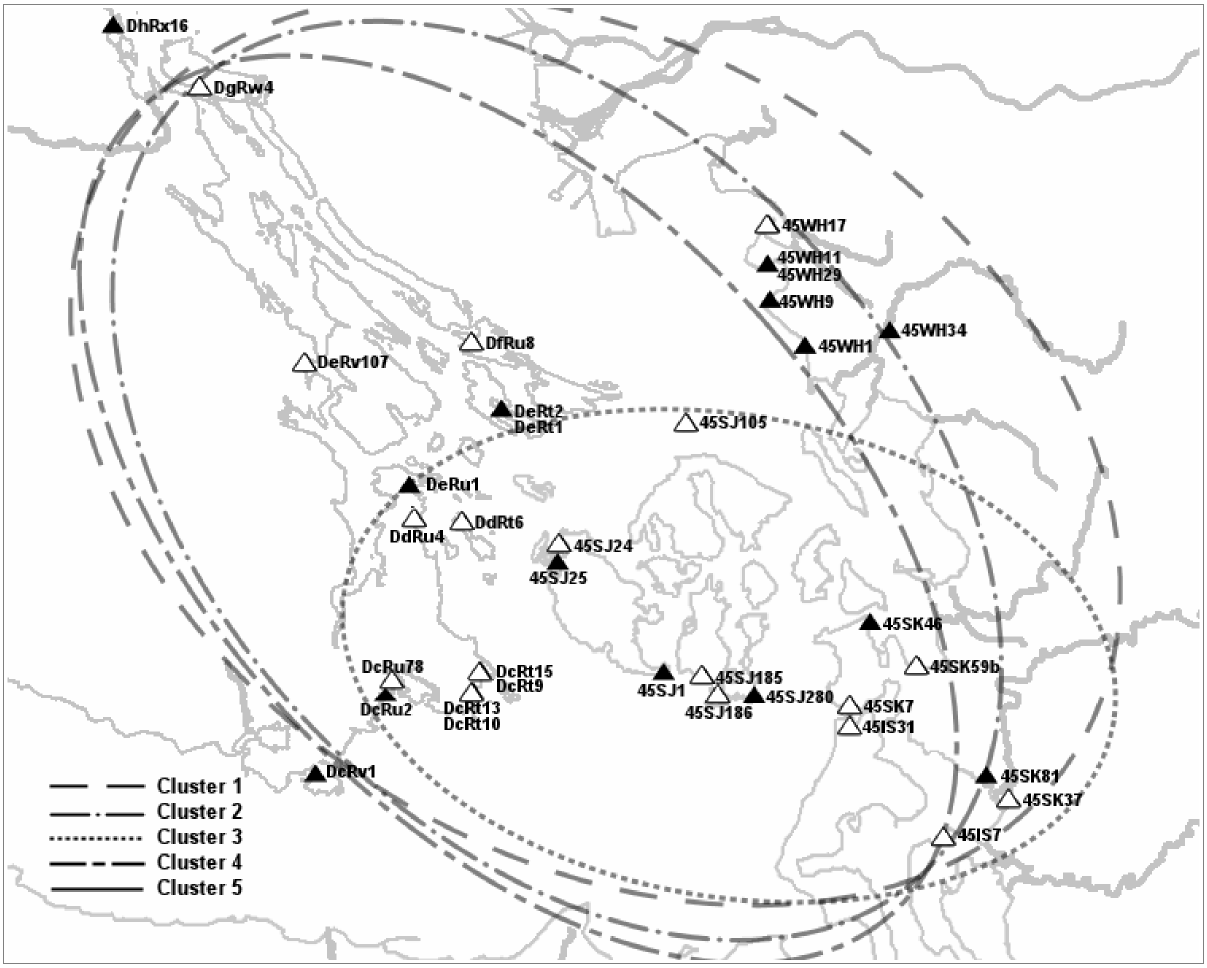


Figure 6.41. Geographic Boundaries of Gulf of Georgia Period Barbed Point Stylistic Attribute Clusters.

Sites with artifacts included in cluster analysis indicated by white triangles.

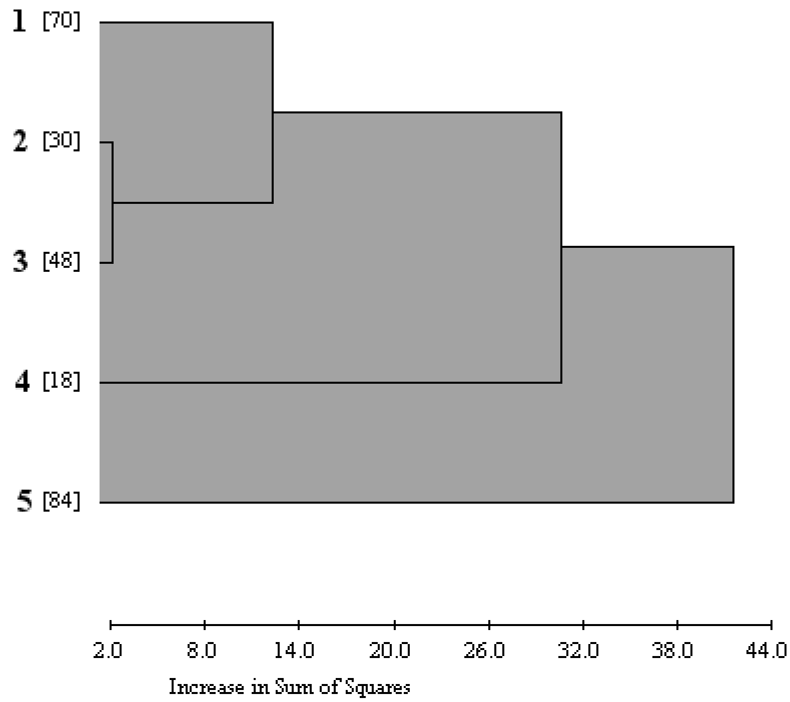


Figure 6.42. Cluster Analysis of Marpole Period Barbed Point Stylistic Attributes.

Member Sites and Cases Per Cluster:

Cluster 1: [45SJ1, 45SJ185, 45SJ280, 45WH1, 45WH9, DcRt10, DcRt15, DcRt9, DcRu12, DcRv1, DeRt1, DgRw4, DhRx16] 11 19 20 21 23 24 25 27 31 32 42 97 102 141 150 152 155 156 157 159 160 161 162 163 166 167 168 172 174 201 207 210 212 217 220 224 232 242 251 255 258 266 267 268 287 291 292 294 295 327 328 331 362 363 367 368 371 376 380 414 416 417 441 442 448 460 471 475 484 505

Cluster 2: [45SJ1, 45SJ280, 45WH1, 45WH11, DcRt15, DcRt9, DcRu12, DcRv1, DgRw4] 13 30 36 91 95 99 138 148 153 154 164 175 176 216 221 222 234 235 238 239 243 248 250 262 288 289 325 361 364 482

Cluster 3: [45SJ1, 45SJ185, 45SJ280, 45WH1, 45WH11, 45WH9, DcRt10, DcRt15, DcRt9, DcRu12, DcRv1, DdRu1, DeRt1, DgRw4, DhRx6, DhRx16] 33 34 40 41 105 147 158 170 177 178 200 206 208 214 223 226 229 233 236 240 241 244 261 263 264 269 270 296 329 332 346 366 370 373 374 381 415 452 463 474 488 491 492 493 499 508 509 514

Cluster 4: [45SJ1, 45WH1, DcRt15, DcRt9, DcRu12, DcRv1, DgRw4, DhRx6] 14 16 35 139 151 165 171 173 219 225 253 256 290 330 365 375 500 515

Cluster 5: [45SJ1, 45SJ280, DcRt15, DcRt9, DcRu12, DcRv1, DgRw4, DhRx16, DgRx6] 12 15 17 18 22 26 28 29 90 92 93 94 96 98 100 101 103 104 106 107 211 213 215 218 227 228 230 231 237 246 247 252 254 257 259 260 265 271 293 333 338 342 347 369 372 444 445 446 447 449 450 451 455 457 461 462 466 468 469 470 472 476 477 478 479 480 481 486 487 489 494 495 496 498 501 502 503 504 506 507 510 511 512 513

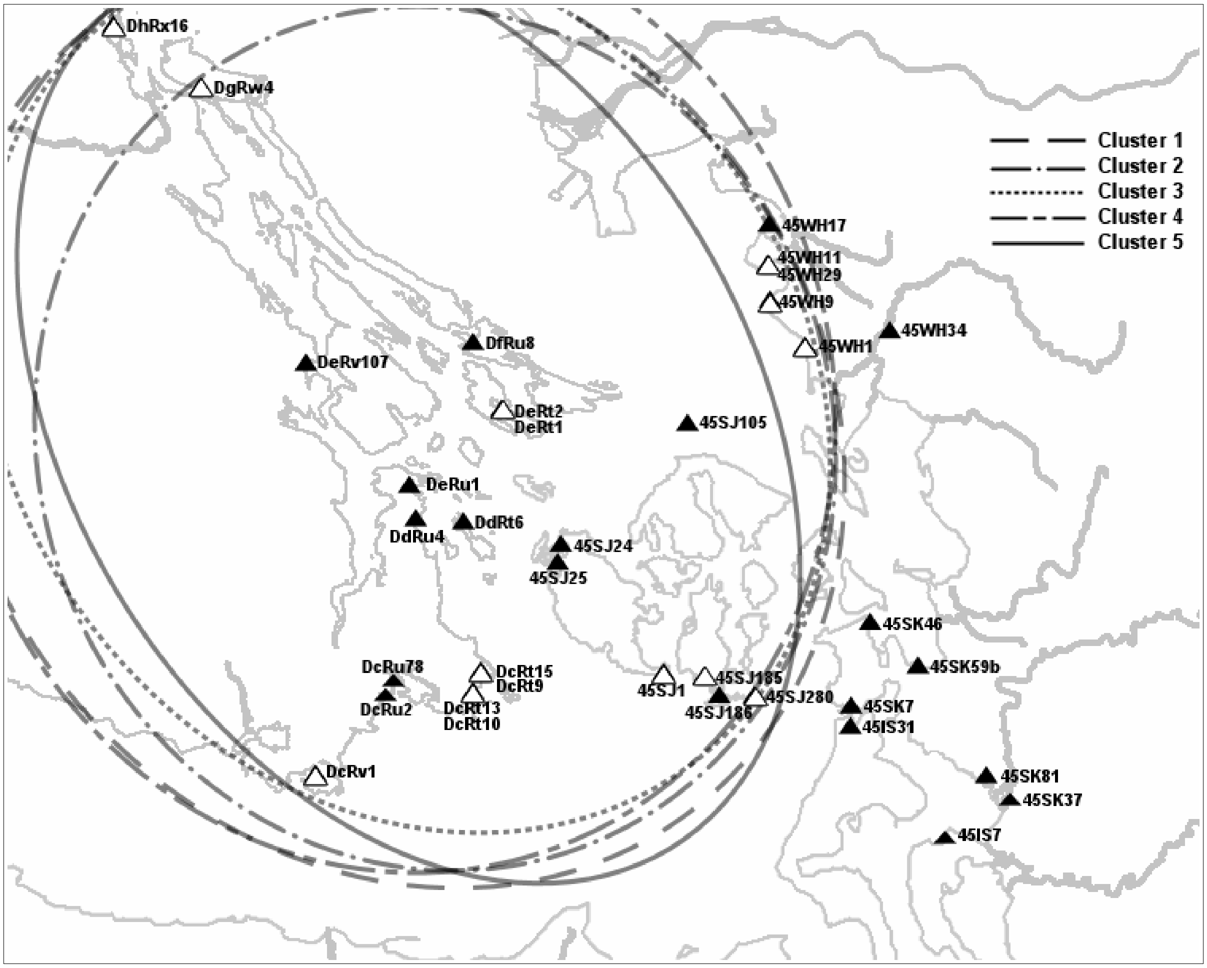


Figure 6.43. Geographic Boundaries of Marpole Period Barbed Point Stylistic Attribute Clusters. Sites with artifacts included in cluster analysis indicated by white triangles.

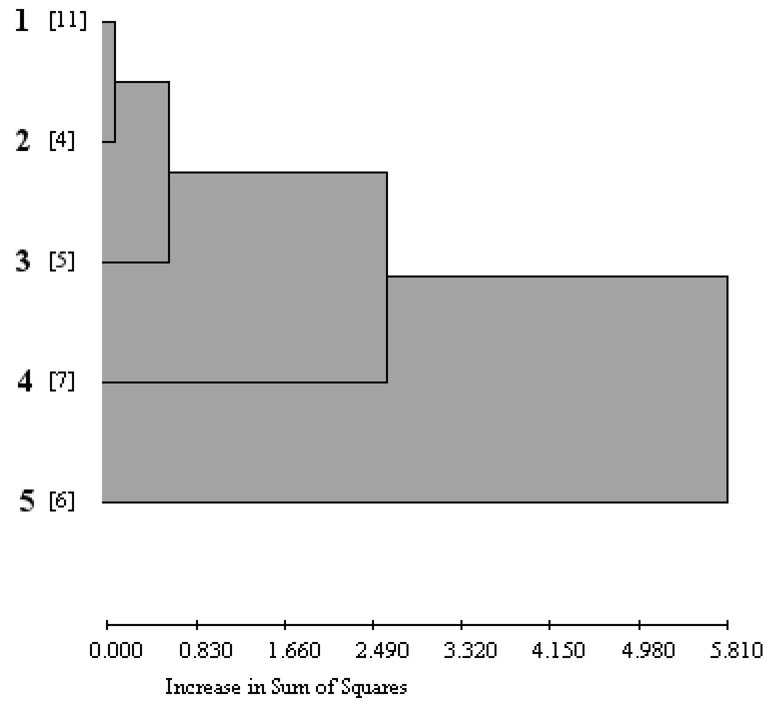


Figure 6.44. Cluster Analysis of Locarno Beach Period Barbed Point Stylistic Attributes.

Member Sites and Cases Per Cluster:
Cluster 1: [45SK46, 45WH1, 45WH17, DeRu1] 110 135 137 142 169 182 183 426 427 431 434

Cluster 2: [45WH1, DeRt2, DeRu1] 134 143 423 429

Cluster 3: [45WH1, 45WH17, DeRt2] 145 146 184 419 421

Cluster 4: [45WH1, DeRu1] 136 140 144 187 428 430 432

Cluster 5: [45WH1, DcRt13, DeRt2, DeRu1] 149 209 418 420 422 433

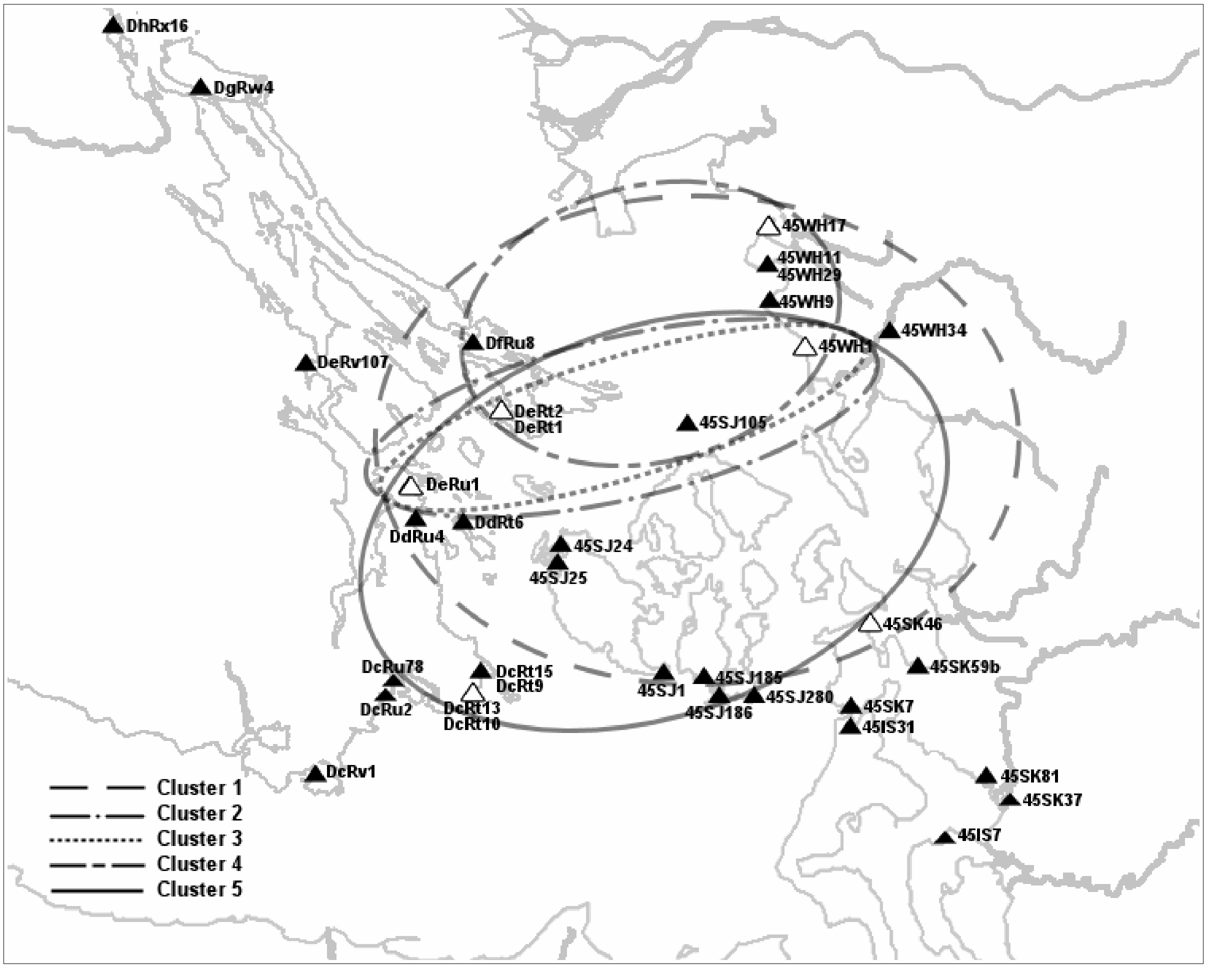


Figure 6.45. Geographic Boundaries of Locarno Beach Period Barbed Point Stylistic Attribute Clusters. Sites with artifacts included in cluster analysis indicated by white triangles.

both squared and straight barbs are found throughout the Gulf of Georgia in all time periods. Based on the results of this analysis, there are no strong localized styles. Combined with the results of the previous analyses examining the frequencies of barb attributes through time it is apparent that different barb styles are found throughout the Gulf of Georgia in similar frequencies over the past 2500 years.

Geographic Distributions of Functional Attribute Clusters

The cluster analyses of functional attributes resulted in some clusters which appear to be geographically distinct, such as Cluster 2 in the analysis of Gulf of Georgia period functional attributes (Figure 6.46, 6.47). This cluster consists of three robust retrievable points. Cluster 2 in the analysis of Marpole period functional attributes is similarly geographically bound, and consists of curved profile points with straight ridged barbs (Figure 6.48, 6.49). These clusters are not believed to actually indicate localized forms, but instead likely reflect the overall rarity of robust barbed points in the Gulf of Georgia period and the small sample size of leisters dating from the Marpole period. The Locarno Beach period cluster analysis (Figure 6.50, 6.51) demonstrates what appear to be regional variants, Cluster 5 has a distinct geographic boundary as it is the only cluster containing DcRt13 and 45SK46. I argue that this, however, is an effect of the small sample size from this period and not the result of more localized forms during the Locarno Beach period.

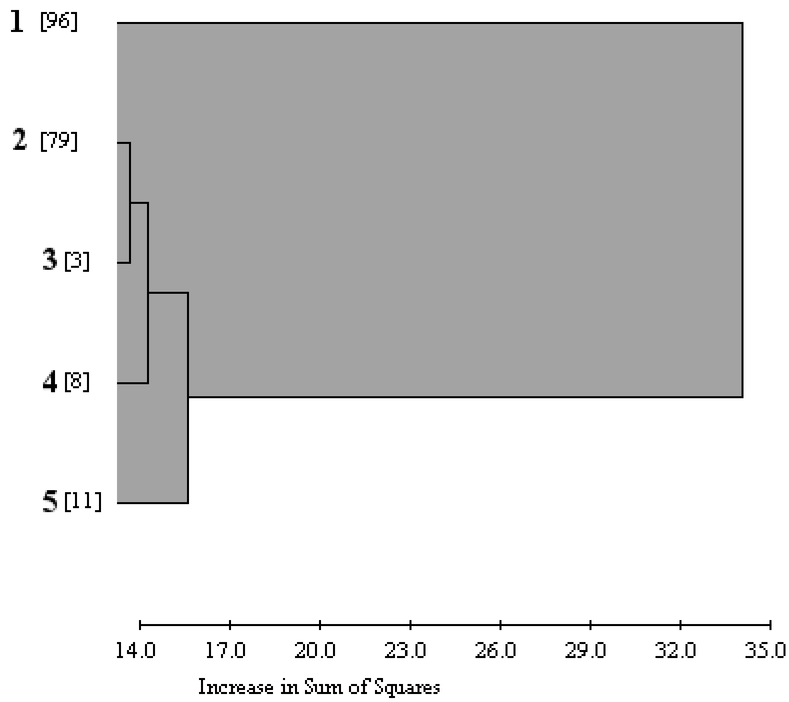


Figure 6.46. Cluster Analysis of Gulf of Georgia Period Barbed Point Functional Attributes.

Member Sites and Cases Per Cluster:
Cluster 1: [45IS31b, 45IS7, 45SJ105B, 45SJ185, 45SJ24, 45SK37, 45SK59a, 45SK7, 45WH17, DcRt10, DcRt16, DcRu12, DcRu2, DcRu7, DcRu78, DdRu4, DeRv107, DgRw4] 5 7 8 39 44 49 50 52 55 57 60 62 63 65 68 69 70 74 76 77 78 79 82 83 84 85 86 87 88 108 111 112 113 114 116 117 119 120 121 122 123 125 130 131 132 179 180 181 202 204 272 273 277 278 279 280 281 282 283 284 286 299 301 304 307 309 310 311 314 320 334 335 337 341 343 344 345 349 352 353 356 360 384 388 390 391 393 396 401 402 405 406 408 437 459 483

Cluster 2: [45IS31b, 45IS7, 45SJ105A, 45SJ105B, 45SJ186, 45SJ24, 45SK37, 45SK59a, 45WH17, DcRt10, DcRt15, DcRt16, DcRu12, DcRu2, DcRu7, DcRu78, DdRt6, DdRu4, DgRw4] 6 9 10 37 38 43 45 48 51 53 56 58 59 61 64 66 67 71 72 73 75 80 81 109 115 118 124 126 127 128 129 188 203 205 245 274 275 285 302 303 305 306 308 312 313 315 316 317 318 319 321 322 323 324 326 336 339 340 348 350 351 355 359 379 387 389 394 397 398 399 400 403 404 453 456 464 467 490 497

Cluster 3: [45SJ24, DdRu4, DgRw4] 47 392 458

Cluster 4: [45SJ24, DcRt15, DcRt16, DcRu78, DdRu4, DgRw4] 46 249 276 358 385 443 454 485

Cluster 5: [45SJ24, 45SJ25, DcRu7, DdRt6, DdRu4, DfRu8, DgRw4] 54 89 357 378 383 386 395 407 440 465 473

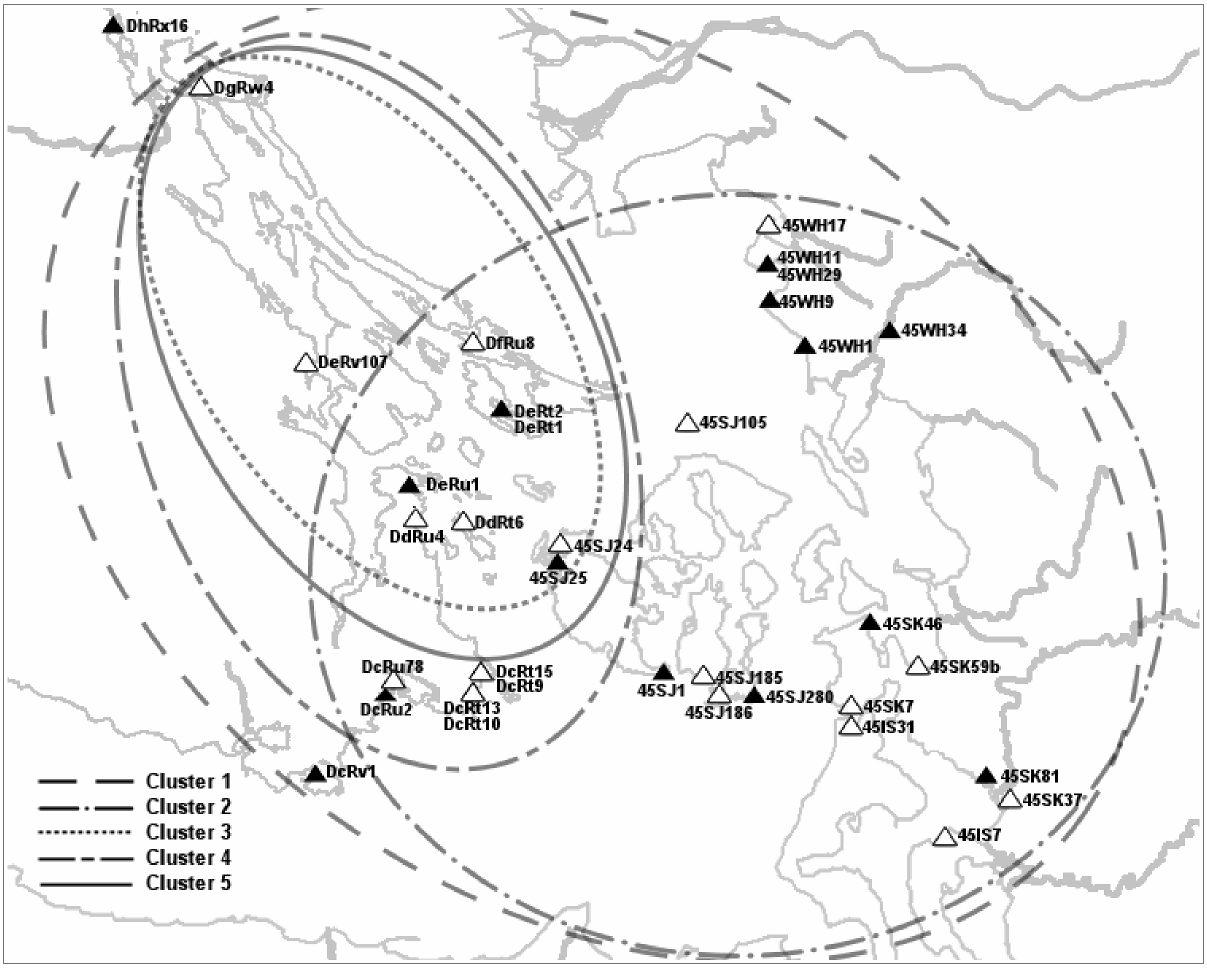


Figure 6.47. Geographic Boundaries of Gulf of Georgia Period Barbed Point Functional Attribute Clusters. Sites with artifacts included in cluster analysis indicated by white triangles.

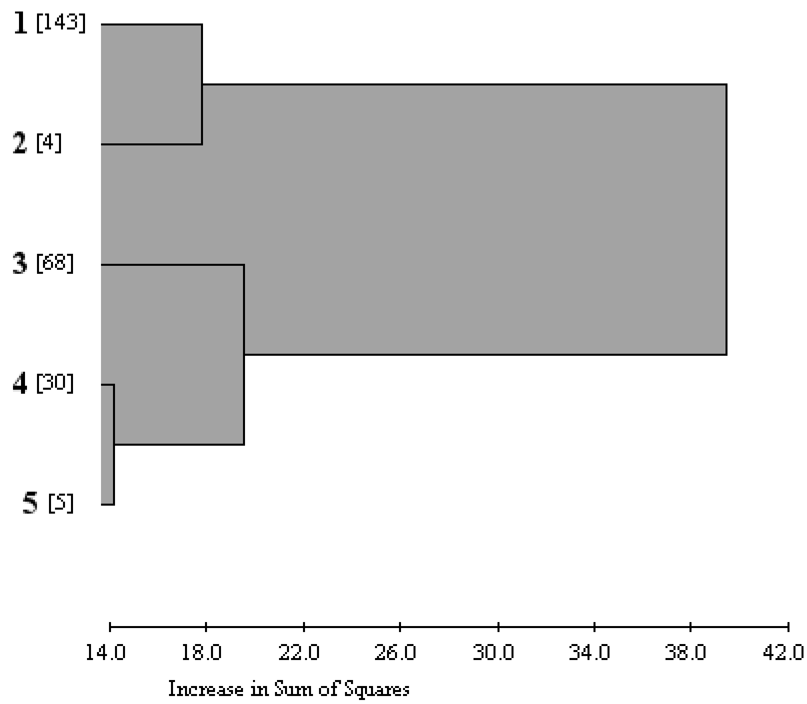


Figure 6.48. Cluster Analysis of Marpole Period Barbed Point Functional Attributes.

Member Sites and Cases Per Cluster:
Cluster 1: [45SJ1, 45SJ185, 45SJ280, 45WH1, 45WH9, DcRt10, DcRt15, DcRt9, DcRu12, DcRv1, DdRu1, DeRt1, DgRw4, DhRx16, DhRx6] 11 13 14 16 20 21 23 24 28 29 30 31 33 35 36 40 91 92 93 94 95 97 99 102 103 107 138 139 141 147 148 150 151 152 153 154 156 157 160 161 162 163 164 165 167 168 170 171 172 175 201 206 213 214 215 216 219 221 224 225 226 229 230 231 234 235 237 238 239 240 241 243 244 248 250 255 256 257 260 261 262 263 264 265 269 270 271 287 291 292 294 295 296 325 327 332 338 342 346 361 362 366 367 368 369 373 380 416 441 445 451 452 455 457 461 462 463 469 470 472 474 477 480 481 484 486 488 492 494 496 498 499 500 501 502 504 506 507 509 511 512 514 515

Cluster 2: [45SJ1, DcRt15] 15 18 236 254

Cluster 3: [45SJ1, 45SJ280, 45WH1, 45WH11, 45WH9, DcRt10, DcRt15, DcRt9, DcRu12, DcRv1, DgRw4, DhRx16, DhRx6] 12 19 22 26 32 90 96 98 100 101 106 155 159 166 173 174 176 200 207 208 217 218 223 227 228 233 242 246 247 251 252 253 259 266 267 268 288 289 290 293 328 329 330 347 363 364 371 372 376 442 446 447 448 449 450 466 471 475 476 478 482 489 491 495 503 505 508 513

Cluster 4: [45SJ1, 45SJ185, 45SJ280, 45WH1, 45WH11, DcRt15, DcRu12, DcRv1, DdRu1, DeRt1, DgRw4, DhRx6] 17 25 27 34 41 42 104 105 158 177 178 211 212 220 222 331 333 365 370 374 375 381 415 417 444 460 468 479 493 510

Cluster 5: [DcRt15, DeRt1, DgRw4] 210 232 258 414 487

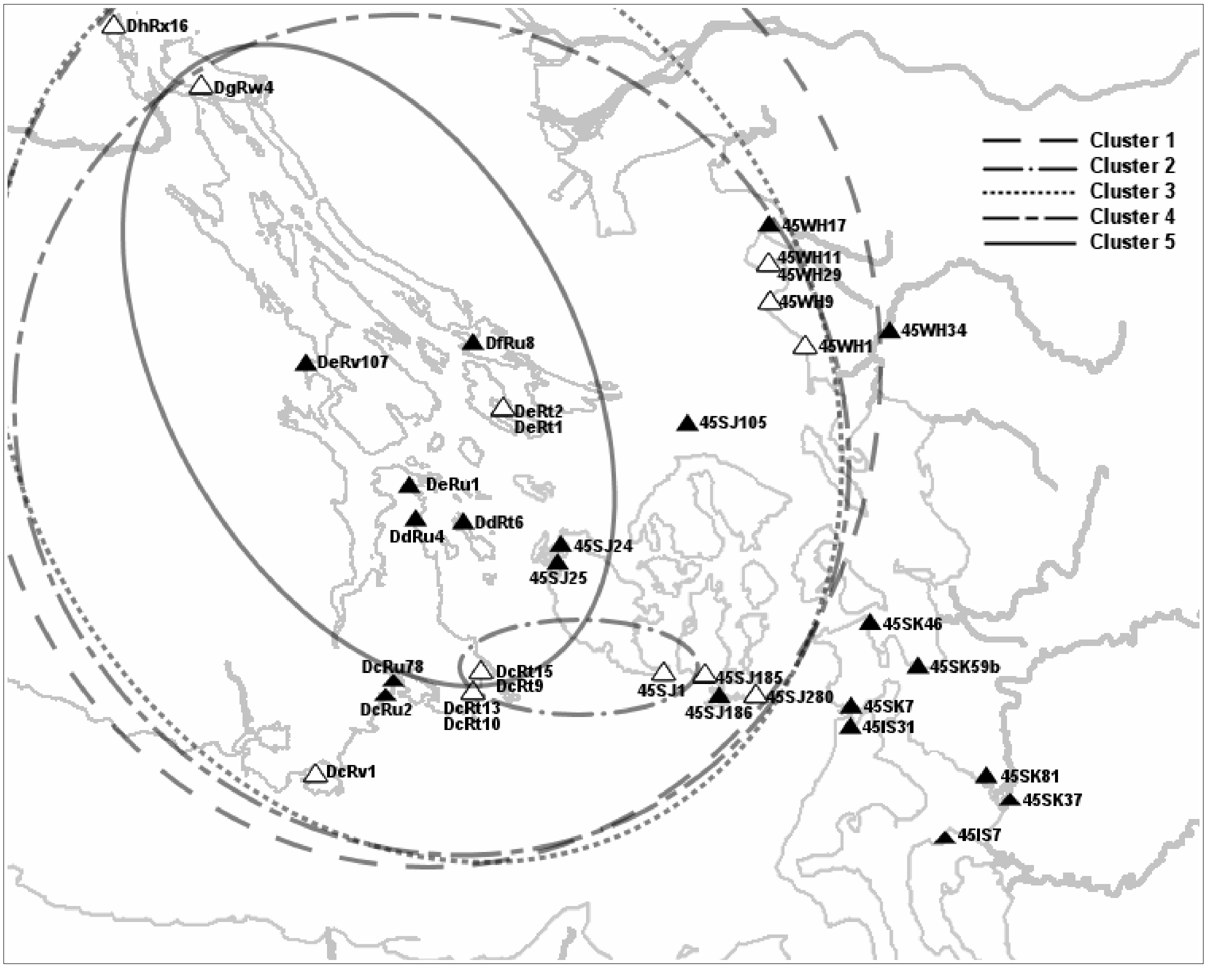


Figure 6.49. Geographic Boundaries of Marpole Period Barbed Point Functional Attribute Clusters. Sites with artifacts included in cluster analysis indicated by white triangles.

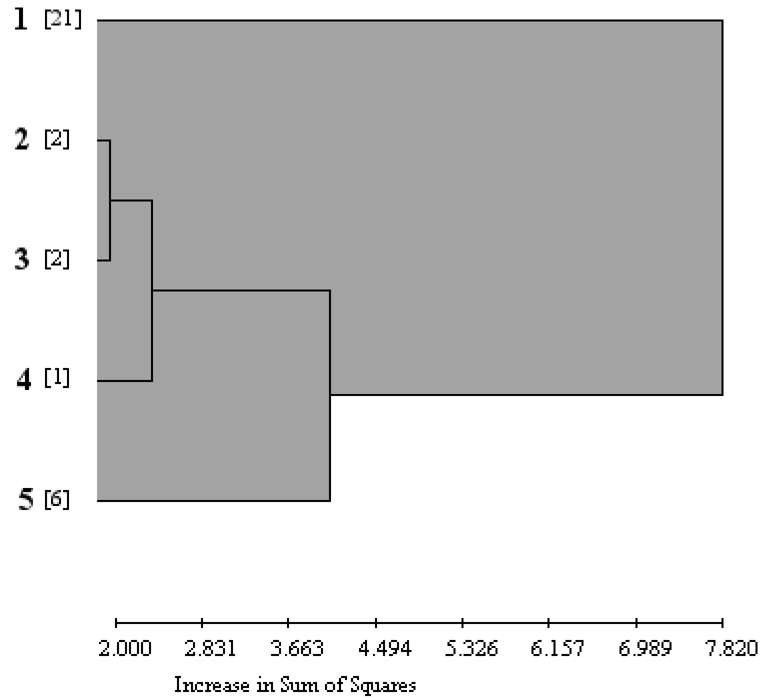


Figure 6.50. Cluster Analysis of Locarno Beach Period Barbed Point Functional Attributes.

Member Sites and Cases Per Cluster:
Cluster 1: [45WH1, 45WH17, DeRt2, DeRu1] 134 135 136 137 140 142 143 144 145 146 149 169 184 418 420 421 422 423 428 429 432

Cluster 2: [45WH17, DeRu1] 183 433

Cluster 3: [DeRu1] 426 434

Cluster 4: [DeRu1] 430

Cluster 5: [45SK46, DcRt13, DeRt2, DeRu1] 110 186 209 419 427 431

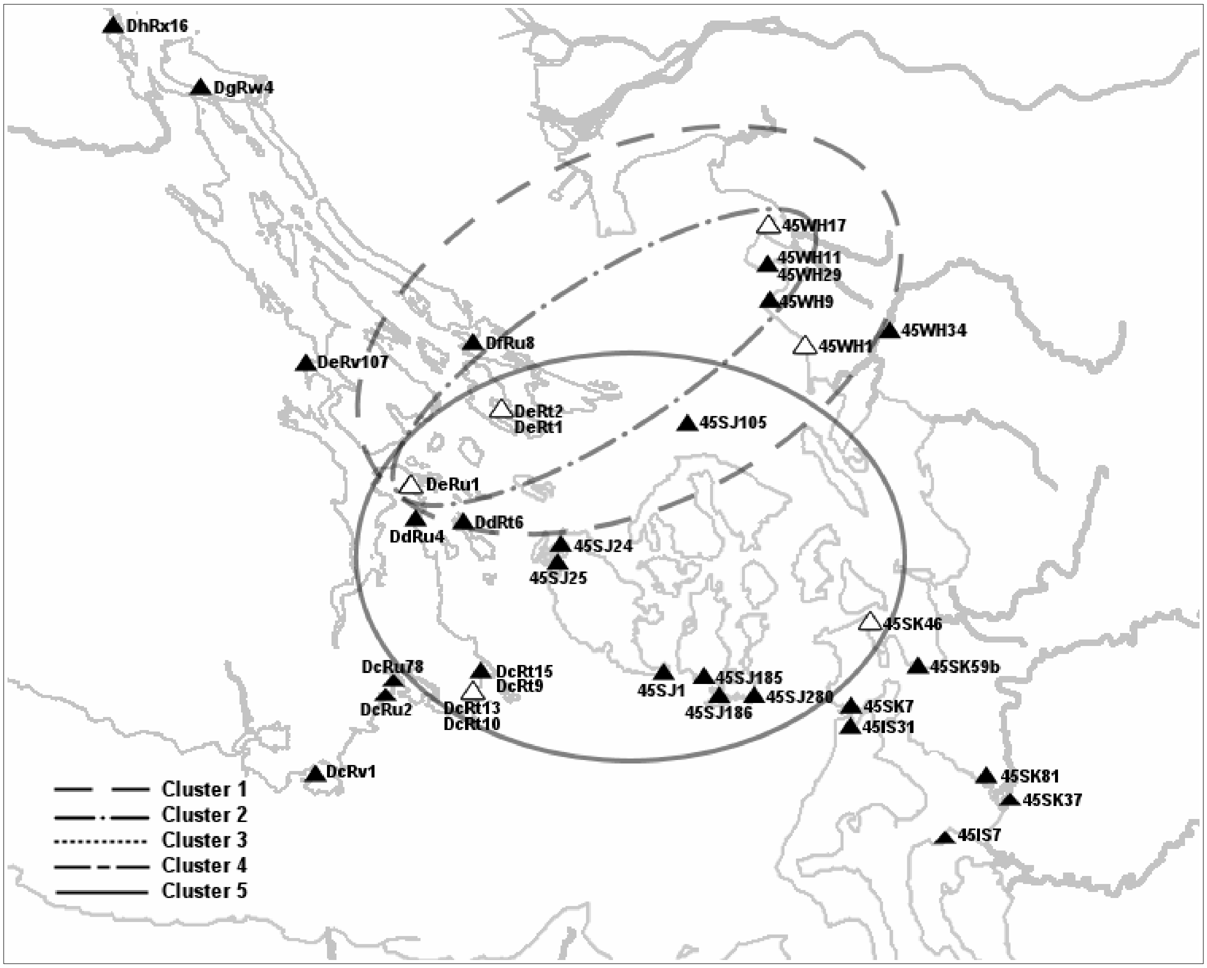


Figure 6.51. Geographic Boundaries of Locarno Beach Period Barbed Point Functional Attribute Clusters. Sites with artifacts included in cluster analysis indicated by white triangles. Clusters 3 and 4, which solely consist of site DeRu1, not indicated on map.

Cladistics Analyses

Based on the results of the analyses earlier in this chapter, shaft barb attributes, with the exception of barb density, appear to be stylistic in nature. Assuming that these attributes are stylistic, high cladogram consistency index and likelihood scores should be indicative of prestige bias, as opposed to directed guided variation. Low consistency index and likelihood scores are attributable to inter-group horizontal transmission, intra-group horizontal transmission, or undirected guided variation.

Contrary to expectations, the cladistics analyses of shaft barb morphology at all scales of OTU (cases as taxa, classes as taxa, and sites as taxa) did not indicate conservative modes of cultural transmission (Tables 6.33 through 6.36). Although data matrix size may have an effect on CI values, there was considerable continuity in the CI values of all claodgrams regardless of OTU. When comparing the highest detected consistency index (classes as the OTU) to simulated CI values for undirected guided variation and conformist bias (Figure 6.52), the observed CI values fall closest to those for undirected guided variation. Eerkens and coauthors' (2006) modeled values of conformist bias were chosen to represent indirectly biased transmission in general, as all forms of indirectly biased transmission are highly conservative in nature. The low CI values found in this analysis suggest that shaft barb shape is culturally transmitted through strong undirected guided variation i.e. individualized learning.

The low CI values, also, mean that the maximum parsimony cladograms produced do not provide information on cultural lineages of shaft barb styles. The maximum likelihood approach, which is better suited for stochastic patterns, demonstrated considerable reticulation within each clade and so do not provide meaningful information on cultural lineages. Although the low observed CI values mean that the cladogram is weak from a technical point of view, from a manufacturing standpoint, the cladograms can be considered strong, as all traits were mutually exclusive, although the shared, derived nature of shaft barbs was an *ad hoc* hypothesis.

Individual artifacts appear to be the OTU most suited for maximum likelihood approaches as they resulted in numerically higher likelihood scores in the heuristic search (Table 6.35). Classes, however, worked well for the maximum parsimony heuristic search, yielding the shortest tree length and highest consistency index (Table 6.33). With the more conservative bootstrap approach, CI values, in general, increased with the scale of OTU as predicted, although artifact class was the OTU which yielded the highest CI value (Table 6.34). Due to the low detected CI values, the rooted cladograms were not informative of culture-historical relationships. Figure 6.53 has been provided as an example consensus tree, and demonstrates the stochastic pattern and weakly supported clades characteristic of all OTUs. Based on these results, I argue that shaft barb morphology, regardless of the intended function of the point, may be tied to highly individualized learning which pulls from a local cultural repertoire, or is connected to inter or intra-group peer learning. Additional discussion is provided in the following chapter.

Maximum Parsimony

Table 6.33. Shaft Barb Shape Heuristic Search.

Taxa	TL	CI	HI	RI
Cases	19	0.32	0.68	0.97
Classes	12	0.33	0.66	0.55
Site	60	0.22	0.78	0.68

Number of Replications=100
Distance Measure= Total Number of Pairwise Character Differences
Optimality Criterion= Parsimony

Table 6.34. Shaft Barb Shape Bootstrap 50% Majority-Rule Consensus Tree.

Taxa	TL	CI	HI	RI
Cases	404	0.02	0.99	0.06
Classes	22	0.18	0.82	0
Site	162	0.08	0.92	0

Number of Replications=100
Distance Measure= Total Number of Pairwise Character Differences
Optimality Criterion= Parsimony

Maximum Likelihood

Table 6.35. Shaft Barb Shape Heuristic Search

Taxa	Ln Likelihood
Cases	-26.91
Classes	-29.76
Site	-202.52

Number of Replications=10
Distance Measure= Total Number of Pairwise Character Differences
Optimality Criterion= Maximum Likelihood

Table 6.36. Shaft Barb Shape Bootstrap 50% Majority-Rule Consensus Tree.

Taxa	Ln Likelihood
Cases	-19.22
Classes	-16.79
Site	-152.77

Number of Replications=10
Distance Measure= Total Number of Pairwise Character Differences
Optimality Criterion= Maximum Likelihood

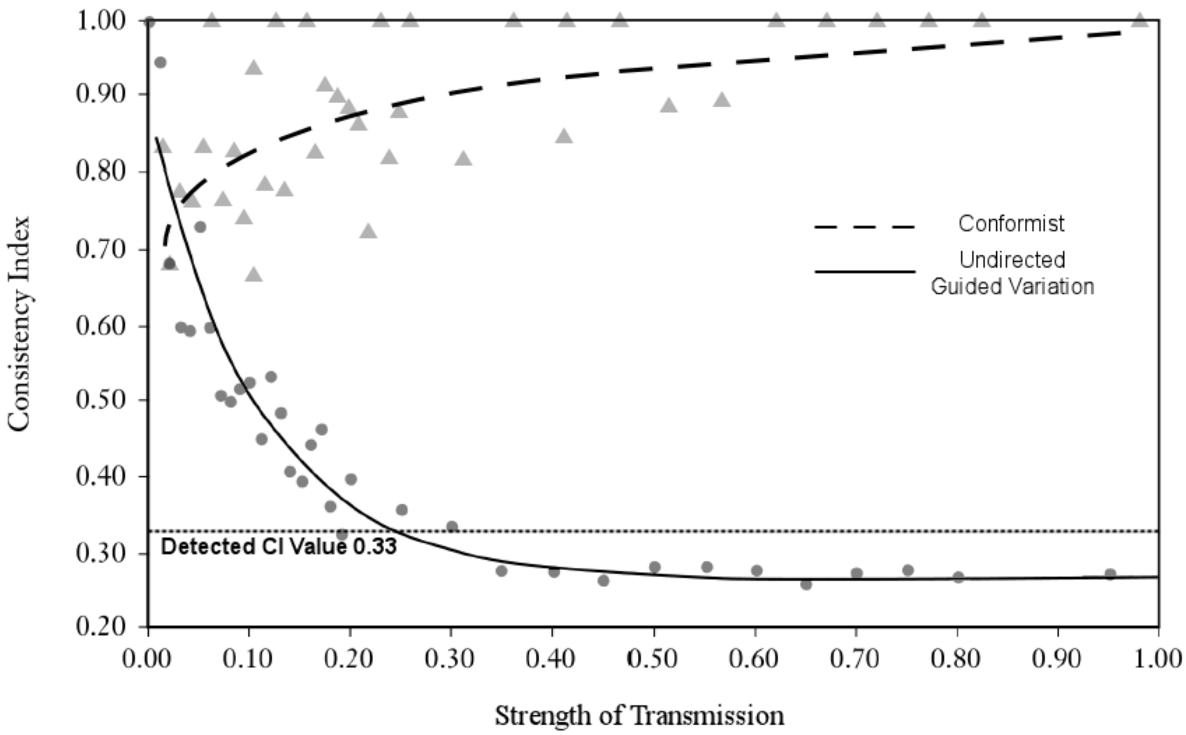


Figure 6.52. Comparison of Highest Detected CI Value to Simulated CI Values for Varying Strengths of Indirectly Biased Transmission and Undirected Guided Variation (Adapted from Eerkens et al. 2006: 176, 178).

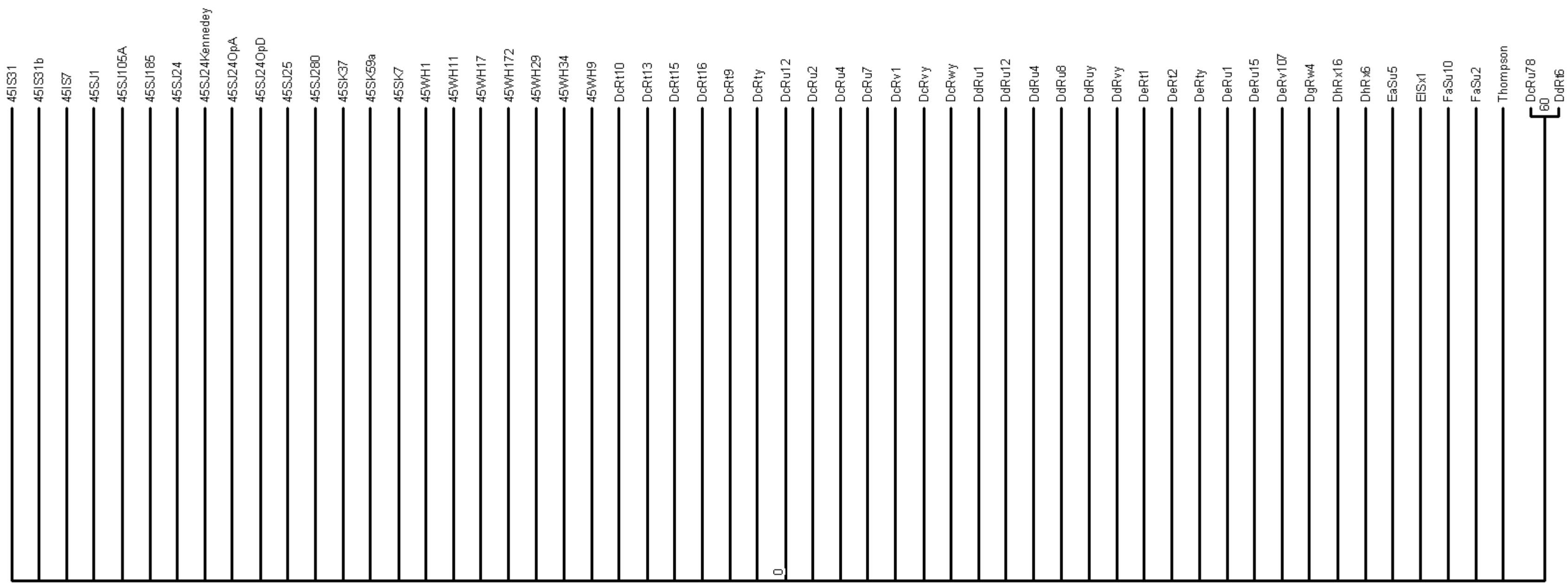


Figure 6.53. Bootstrap 50% Majority-Rule Consensus Tree, Sites as OTU. No clades were strongly supported, with the exception of DcRu78 and DdRt6 which form one moderately supported clade. Rooted using EaSu5, ElSx1, FaSu2, and FaSu10 as the outgroup.

VII. DISCUSSION AND IMPLICATIONS

The results of my analysis are discussed in four sections below. The first reviews the modes of cultural transmission of barbed bone and antler technologies, and provides models that explain the implications of the cladistics and cluster analyses in Chapter 6. This is followed by a comparison of this study to other studies regarding the cultural transmission of material culture, and a critique of cladistics as a method of exploring cultural transmission. The variation of barbed point types and attributes is then discussed, with a comparison to the findings of earlier studies of Northwest Coast barbed points.

Cultural Transmission of Barbed Bone and Antler Technologies

The low consistency index values detected in the cladistics analyses (Tables 6.28-6.31) indicate that conservative forms of cultural transmission are not involved in the transmission of the barb styles of barbed spears, leisters, barbed arrows, and harpoons in the Gulf of Georgia. Although a stochastic pattern of cultural transmission was detected, I argue that these results are not consistent with rapid diffusion of barb traits, as nearly all barb attributes are present in all time periods and geographic regions (Table 6.21, Figures 6.40-6.51). It is apparent that there is considerable continuity in barb styles over the past 2500 years. While barbs serve a role in point function, I argue that the variation of shaft barb attributes, with the exception of frequency, is stylistic in nature. I suggest that shaft barbs do not share the same degree of functional constraints as attributes such as projectile length, width, base type, or head barb morphology.

Based on the cluster analyses it is apparent that barbed points of all functional types are present throughout the Gulf of Georgia. These attributes, which are under direct functional pressures,` may demonstrate morphological similarity due to convergent evolution as opposed to diffusion. Some of the changes in functional attributes such as the transition from bilateral to unilateral barb application during the Locarno Beach period, or the development of socketed harpoons, may be attributable to rapid diffusion due to their functional adaptiveness as discussed by Croes (1997).

Despite the stochastic pattern in the transmission of shaft barb styles, there is a high degree of continuity in the barb styles seen through time, as indicated by the relative frequencies of barb classes through time (Table 6.23). The stochastic pattern in the cladistics analysis indicates that the production of barbs was either a highly individualized process which involved a high degree of experimentation (guided variation) or involved the sharing of cultural information regarding the proper construction and use of these technologies by peers (horizontal transmission).

Based on the results of the cluster analysis (Figures 6.40-6.51), there are no distinct regional styles for shaft barbs, with the exception that the combination of microbarbs and ridged barbs was not present throughout the entire region. Individuals producing barbed points throughout the region appear to have been drawing from the same cultural repertoire, which could be a result of a high degree of inter-group interaction, similar to the historic period where Coast Salish individuals had access to the resources held in trust by their expansive kin groups.

Several factors may have prevented the detection of prestige bias if present. Certain technologies such as barbed spears and leisters may have been viewed as less prestigious and may have been less subject to prestige bias. For instance tanged harpoons in particular would be expected to have a social learning context dominated by prestige bias, as they would be used in tasks which would presumably be more prestigious in nature than the procurement of salmon (i.e. capturing marine mammals, terrestrial mammals, or sturgeon). Although this analysis did not distinguish between barbed point functional types, the low consistency index values, and harpoons as the second most common barbed point type, suggests that it is unlikely that a conservative cultural transmission signal was masked.

Cladistics, as employed by Eerkens and his coauthors (2006) and in this analysis, is unable to detect chronological changes in cultural transmission. As a method it is more suited for comparing differences in the transmission of two areas, groups, or technologies. This means that there is a second potential issue that may have prevented the detection of prestige bias. If there was a transition from non-conservative to conservative cultural transmission through time, it could mask a more conservative cultural transmission signal in later time periods. I argue that this was not the case here, as this sample was biased towards later time periods, from 2500 BP onward. By this time, the developed northwest coast pattern had emerged (Mitchell 1990; Matson and Coupland 1994; Ames and Maschner 1999). If prestige bias was present during this time period it would be expected to mask the stochastic pattern of earlier time periods if cultural transmission had become more conservative over time.

My interpretation of these results relies upon the notion that different aspects of a technological tradition may depend upon different cultural transmission mechanisms. Bleed (1991, 2001) as well as Fischer and Eriksen (2002) argue that artifacts consist of technological recipes, i.e. operational sequences of tool production, and the combinations of these sequences of tool production are passed on through social learning and form intellectual lineages. Taking this concept a step further, differing stages of a technological production sequence may be influenced by differing modes of cultural transmission. Combining David's (2003) *chaîne opératoire* analysis of Mesolithic European harpoons as a basis for production stages with Riede's (2008) interpretation of their cultural transmission factors, conservative forms of cultural transmission play a role in the early stages of production such as the selection of blanks, while final stylistic touches such as barb morphology are highly individualized. From this perspective, attributes which demonstrate considerable morphological variation but are functionally equivalent, such as certain attributes of shaft barb morphology (barb shape, extension, and the presence or absence of barb ridges and microbarbs) may serve as identity markers.

Boas (1899) discusses property marks on Aleut barbed points and composite harpoons, these marks range from notching to geometric patterns. He noted, however, that the majority of these projectiles lacked such markings and hypothesized that the general morphological differences in projectiles between villages, and smaller scale 'ornamental' differences on those within a village, served to identify them. These 'ornamental differences' are not specifically the property marks discussed by Boas, but general stylistic variation.

Thompson (1978) suggests that what I have termed microbarbs are similar stylistic markers. When viewing artifact attributes from a perspective of having communicative potential and functional importance in their morphological variation (Figure 7.1), the morphological variation of shaft barbs and microbarbs would have high communicative potential but low functional importance. The 'communicative potential' is used as opposed to O'Brien and Lyman's (2003) original term, 'communicative importance,' as communication is an intentional act. Artifacts can be constructed with a high degree of communicative potential in their attributes, but there is no guarantee that the information will be encoded, let alone received. Following McMurdo's (1972:114) line of reasoning that line attachment types are functionally equivalent, line attachment styles would have high communicative potential but low functional importance in their variation. There may, however, be specific functional importance for certain line attachment methods such as bilateral line attachments, perhaps tied to requiring a more robust retrieving line and line attachment for larger tanged harpoons used for marine mammals. Experimental evidence is required to test this assertion.

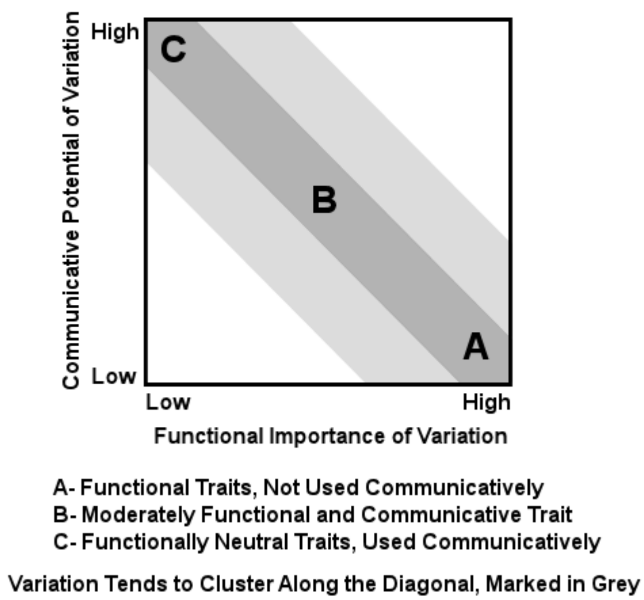


Figure 7.1. Functional Importance and Communicative Potential of Morphological Variation (Adapted from Lyman and O'Brien 2003: 37).

With the considerable degree of inter-group interaction in the Gulf of Georgia, and the relationship between extensive kin relationships and access to resources, barb morphology may have consciously or unconsciously served a purpose as identifiers for both groups and individuals throughout the Gulf of Georgia. The stochastic pattern of the shaft barb morphological attributes of tanged harpoons, leisters, barbed spears, and barbed arrows combined with the fact that other aspects of barbed point form appear to be shared throughout the region may be indicative either of individualized learning, or peer-based learning (e.g. Eerkens et al. 2006; Henrich and Henrich 2007).

It is apparent that head barbs demonstrate morphological variation by functional class, and are likely crucial to the overall function of types such as retrievable points. However, I suggest that shaft barb attributes, with the exception of frequency, are functionally equivalent. This means that the functional importance of shaft barb morphological variation may be low, but this variation may have high communicative potential. Experimental studies should examine the functional importance of attributes such as barb symmetry (e.g. Gifford 1940; Rau 1885), and density (McMurdo 1972:112-113).

Comparison With Previous Cultural Transmission Studies

Cultural transmission studies using material culture have primarily attempted to detect whether cultural transmission is conservative in nature (i.e. vertical or horizontal transmission) (e.g. Shennan and Collard 2000; O'Brien et al. 2001; Tehrani and Collard 2002; Jordan and Shennan 2003; O'Brien and Lyman 2003; Croes et al. 2005; Lipo et al. 2006; Collard 2007; Croes, et al. 2008). When conservative transmission is detected cultural cladistics analyses have generally assumed vertical cultural transmission (parent to offspring) in the interpretation of cultural lineages, an approach which has faced critique (Borgerhoff-Mulder et al. 2006). This analysis has attempted to address the concerns raised by Borgerhoff-Mulder and his coauthors by focusing upon the role of cultural transmission mechanisms (e.g. Henrich and Gil-White 2001; Bettinger and Eerkens 1999; Eerkens et al, 2006; Henrich and Henrich 2007).

The results of this study correspond with the findings of Jordan and Mace (2008), discussed in Chapter 4, in that the cultural transmission of Coast Salish technologies differ according to their specific contexts. A comparison of the work of Croes and coauthors (2005) with Jordan and Mace's (2008) study also has implications for future cultural transmission studies for the region. Croes and coauthors (2005) argued that the cultural transmission of Coast Salish textiles was conservative in nature, consisting of closely guarded family styles that were passed from mothers in-law to daughters in-law (oblique transmission). Jordan and Mace's (2008) findings differed, and they argued that the transmission of the manufacturing methods of Coast Salish textiles demonstrated a stochastic pattern with manufacturing methods being transmitted across linguistic barriers as a result of patrilocal movement. Jordan and Mace do not mention the findings of Croes and his coauthors in their article, and I argue that in fact their findings may not conflict. Jordan and Mace (2008) examined differences in the technologies used for the production of textiles, which I argue could indicate differences in the early stages of the production sequence. In contrast the attributes examined by Croes and coauthors (2005) were individual weave styles, which may be independent of the attributes examined by Jordan and Mace. I argue that it is plausible that differing stages of the production sequence of textiles may operate under differing modes and mechanisms of cultural transmission. I suggest that barbed points also exhibit the operation of differing transmission modes and mechanisms at different stages of production.

Assessing Cladistics as a Method of Determining Modes of Cultural Transmission

What has been glossed over in many cladistics analyses of material culture is the value of using cladistics as a method of exploring specific hypotheses regarding the modes and mechanisms of cultural transmission, as opposed to assuming 'vertical' transmission (see Bettinger and Eerkens 1999; Henrich 1999; Eerkens et al. 2006 for examples where vertical transmission is not assumed). This analysis attempted to answer a specific question regarding conservative cultural transmission, whether or not prestige bias was a factor in the social learning of barbed bone and antler point technologies. I attempted to account for issues resulting from strong artifact functional constraints, a factor not considered many studies of the transmission of material culture. Strong functional constraints (directed guided variation) can result in a 'false' phylogenetic signal (due to homplasy), which can be misinterpreted as conservative cultural transmission (homology). A second issue that should be addressed in future phylogenetic studies is ensuring that symplesiomorphic characters, ancestral characters shared by one or more taxa, are not selected. Selecting chronologically sensitive attributes present in a single functional type may be a method of avoiding symplesiomorphy. Choosing attributes unique to a functional class can be difficult even in artifacts with considerable morphological variation and may not be feasible for many analyses.

Although conservative cultural transmission was not detected in this study, I argue that while specific attributes may not yield a strong phylogenetic signal, they are not random 'noise,' i.e. that they are not meaningless in interpreting the cultural transmission involved in the creation of an artifact. While certain attributes and combinations of attributes may not yield a phylogenetic signal indicating conservative cultural transmission and thus be amenable to reconstructing a phylogeny, artifacts are the sum of socially transmitted behaviors. All aspects of a technology are subject to either factors of cultural transmission or individualized learning.

Ignoring artifact traits because they do not yield phylogenetic signals, I argue, is akin to discarding lithic debitage because they are not finished artifacts. By ignoring these attributes, evolutionary archaeologists are potentially ignoring a wealth of information regarding the social learning contexts of technologies. For instance, this 'noise' may be valuable when attributes are examined in terms of production sequence. For a comprehensive analysis of the transmission of an artifact type, attributes from multiple stages of the production sequence should be separately examined, each stage of a production sequence being akin to Hennig's (1966:65-66) concept of the semaphoront. I argue that bearing production sequences in mind, in addition to the communicative potential and functional importance of attributes, can result in insights for reconstructing technological phylogenies. Similarly, other methods may be better suited to examine the cultural transmission of archaeological data than cladistics, such as Mantel tests of matrix correspondence and network analysis (e.g. Jordan and Mace 2008).

Barbed Point Type and Attribute Variation

With the exception of combining barbed arrows and barbed spears into the class of fixed points, the functional classes used in this analysis followed the functional typology by Carlson (1954:24) and McMurdo's (1972:108, 114-117) interpretation of functional classes, although the terminology differs (Table 2.1). Based on the results of this analysis there are clear distinctions between retrievable points, fixed points, and barbed unipoints in metric characters such as width and thickness (Figure 6.22-6.24, Figure 6.34). Leisters and straight profile fixed points demonstrate more morphological similarity to each other than other classes, but have distinct functional differences such as the presence of curved profiles or asymmetrical bases for the purpose of side-hafting. However, according to ethnographic evidence (e.g. Suttles 1951, Barnett 1955) leisters and straight profile fixed points were multipurpose in nature. Due to this multipurpose nature, the degree of morphological variation and overlap seen in and between straight profile fixed points and leisters was not entirely unexpected.

I found curved profile was a meaningful diagnostic trait for leisters, as used in previous studies (e.g. King 1950; Borden 1950; Carlson 1954; McMurdo 1972). However using this attribute alone for leister classification ignores the possibility of leisters with straight profiles as noted in Leroi-Gourhan's (1946:326) study of Northwest Coast barbed points. The inclusion of fixed points with asymmetrical bases is recommended as this better accounts for the observed morphological variation of this functional class.

Future analyses should also consider recording the presence or absence of the natural metapodial groove. McMurdo (1972:116) suggests that the natural groove may have been used to aid in lashing a fixed point to a shaft. Few artifacts in the sample retained metapodial grooves because most were extensively worked, and so this character was not used in this analysis. However, the potential functional importance of the groove for hafting should not be overlooked.

While projectile width/thickness index ratio was used in lieu of a direct observation of cross-section shape, significant morphological distinctions within 'fixed points' which Carlson (1954) argued were indicative of function as a fish spear or bird arrow were detected

(Figure 6.35). I suggest that the cross section of straight fixed points may be indicative of their function. There is however more overlap in attributes between barbed spears and barbed arrows than Carlson implied, as fixed points with circular cross-sections may have either conical or wedged bases. Other attributes such as base length, which is tied to the size of a point's hafting area, as Clark (1975:129-130) argued, should vary depending on a barbed point's function as a fish spear or bird arrow. However, they did not demonstrate variation corresponding with changes in cross-section (Figure 6.36) and may not be meaningful distinctions for Northwest Coast barbed points.

I did not find material type to be a meaningful attribute to divide functionally equivalent barbed points into classes, although McMurdo (1972:113-114) hypothesized a tendency to utilize antler and marine mammal bone to construct the robust points used in procuring marine mammals. Even though antler points, especially those dating from the Marpole period, are generally more robust, I do not believe that material use is as chronologically sensitive as McMurdo (1972:119) argued. On a similar note, I argue that functional study of barbed points should, in fact, be more inclusive in nature, as opposed to focusing on barbed points constructed from solely bone or antler. Instead, these technologies should be studied in terms of artifacts with similar production sequences regardless of material type. Barbed wood points, I argue, are an example of an artifact with a similar production sequence to barbed bone and antler points, and should be included in a more inclusive approach.

Croes (1995) recovered a number of tanged barbed wood points from the Hoko wet site. These artifacts demonstrate the same attributes as the barbed bone and antler points, and arguably would have a similar production sequence. Based on the prevalence of barbed wood points at the Hoko wet site, Croes (1995:169) hypothesizes that wood was, in fact, the most commonly utilized material for barbed points in the Locarno Beach period. He suggests that barbed wooden points from the Locarno Beach period demonstrate considerable morphological similarity to Marpole period barbed points, specifically similar line attachment styles. Despite this morphological continuity, Croes argues that the use of wood as a material was replaced by antler and bone technologies during the Marpole period. It is clear that wood was likely widely utilized as a material for points and is underrepresented in the archaeological record.

Croes (1995:169) also notes the absence of socketed wood projectiles from wet sites such as Ozette and Hoko river, implying that wood was not a material utilized in the construction of composite harpoons. This is not surprising due to the use of the natural curvature of antler in the production of composite harpoon valves (Hoover 1971; Stewart 1973:86, 109). Again, I emphasize that future examinations of barbed points should be more inclusive and examine barbed points regardless of material.

This analysis did not investigate the role of barbed point re-use and remodeling. King (2007:112) hypothesizes the importance of re-use for small bone points in general. Used barbed points may be rejuvenated into smaller artifacts for new purposes, although evidence for the re-work and re-use of bone tools may be more subtle and less obvious than the re-use of chipped stone. Future analyses, especially those investigating the production sequences of worked bone on the Northwest Coast, should account for this possibility.

Changes in attributes through time, specifically barb application and line attachment methods, correspond with analyses by Drucker (1943) and McMurdo (1972) and the trends discussed by Bennyhoff (1950) in his analysis of Northern Californian fish spears and harpoons. Bilateral barb application and asymmetrical barbs appear to primarily date from the St. Mungo period, and are diagnostic traits of early (pre-3200 BP) barbed points. McMurdo's (1972:119) observations of increased use in antler as a material during the Marpole period (Figure 6.38) are apparent in this sample. However, her interpretations regarding barb attributes indicative of specific cultural periods such as straight, enclosed, low profile barbs being more common during the Marpole period are not supported in this data set (ibid). The rank order of barb paradigmatic classes through time are relatively consistent (Table 6.22), which indicates that barb morphological attributes other than barb application and asymmetry are not chronologically diagnostic.

Barbed Technologies and The Fraser Valley Fire Period

A number of Northwest Coast archaeologists have noted the distinctive nature of Marpole retrievable points (e.g. McMurdo 1972, Burley 1980, Mitchell 1990). Retrievable points from this period tend to be constructed from antler, are more robust than those from other time periods, and have bilateral line attachment methods not seen in the Gulf of Georgia or Locarno Beach periods (Table 6.23). As discussed in Chapter 2, these points pose an intriguing problem in understanding the chronology of barbed points in the Gulf of Georgia.

Borden (1950, 1951, 1954) speculated that Marpole barbed point styles resulted from the diffusion of technologies from the interior. Later research has emphasized the cultural continuity between the Locarno Beach and Marpole periods (e.g. Matson 2008). McMurdo (1972:124) argued that the changes seen in Marpole barbed technologies appear to be an in-situ development, one potentially attributable to an environmental cause. McMurdo's assertion, made over three decades ago, has been since supported by Croes (1995:169) who indicated continuity between the Locarno Beach and Marpole barbed point styles. The stylistic similarities between Locarno Beach period wood points at wet sites such as Ozette and Hoko (ibid) supports the notion of Marpole barbed points being a localized coastal development as opposed to the result of diffusion from the interior.

More recent climatic work I argue may fit with the 'environmental cause' that McMurdo speculated as responsible for the changes seen in Marpole barbed point technologies. Lepofsky and her coauthors (2005) argue that the Marpole period is concurrent with an increase in forest fires attributable to persistent summer droughts resulting from increased solar output. Termed the Fraser Valley Fire Period (FVFP), Lepofsky and coauthors argue that salmon abundance or predictability was heavily impacted in the southern northwest coast while the stability and predictability of other resources near offshore areas and small tributaries increased as a result of this increase in temperature. According to Schalk (1977), runoff and water temperature are two critical components to the stability of riparian ecosystems. The immature life stages of salmonids in particular are sensitive to minor temperature fluctuations. The increased temperatures and late summer droughts tied to the FVFP would affect spawning success and timing, leading to later runs (Lepofsky et al. 2005). Increased siltation of streams following fires would also negatively impact the survival of eggs. The rise in global temperature during the FVFP may have had strong impacts on small drainage systems where according to Schalk (1977) species diversity would be more limited. As harpooning requires clear water for visibility (Suttles 1951), the increased siltation of the FVFP could also limit the seasonality of harpoon use for the procurement of salmon upstream in addition to its impacts on the timing of salmon runs.

Lepofsky and coauthors (2005) argue that while salmon runs on the Fraser were reduced, they were generally buffered from local environmental variation. The productivity of many runs were controlled by conditions in upstream tributaries in the interior that were under different climactic conditions. However, in other regions of the Gulf of Georgia, such as those examined in this analysis, the affects of the FVFP would not be as buffered and the impact of this climactic change would be expected to be greater. Lepofsky and coauthors (2005) argue that this would have resulted in the Fraser River being, relatively, the most abundant and predictable fishery in the region during the Marpole period. In this model, the complex social relations which emerged during the Marpole period resulted from the contrasts in the availability and reliability of resources in the Fraser river valley and Gulf of Georgia. Lepofsky and her coauthors suggest that resources unique to the drier ecosystems of the Gulf Islands and eastern Vancouver island such as camas and acorns (which they argue would be more abundant on the islands than in the Fraser river valley) were likely traded with groups on the Fraser.

Changes in Faunal Assemblages

Lepofsky and coauthors (2005) predict a relative decline in salmon and increase in deer due to the decline in salmon populations in the Gulf Islands and Vancouver Island during this period. Lepofsky and coauthors (2005) cite faunal analyses of Marpole period site components (e.g. Imamoto 1976; Boucher 1976; Monks 1977), and argue that they indicate that the species procured during this period matched with the ethnographic record. According to Cannon (1996), these analyses were at a broad scale, and did not examine shifts in the use of animal resources through time. While Croes and Hackenberger (1988) detected increased use of Salmon during the Marpole period at Hoko, this may not conform with changes in the Gulf of Georgia.

Although Lepofsky and coauthors (2005) argue that the current Marpole faunal and botanical record lacks the resolution to detect such changes but that the development of new sampling schemes and identification methods will assist in answering this question, her hypothesis can be preliminarily assessed using faunal data compiled by Butler and Campbell (2004). Using data from multi-component assemblages they examined, sites from the Gulf of Georgia and Fraser river area were selected to investigate changes in salmon and cervid indices though time. There is an apparent decline in the ratio of salmon to other fish in the site components of Crescent Beach, Decatur Island, and Tsawwassen dating from 1500-2500 BP (Figure 7.2). An increase in the ratio of cervids to other mammals is seen during this time period at Decatur Island and Tsawwassen (Figure 7.3).

While not directly comparing cervids to salmonids, the general trends predicted by Lepofsky and her coauthors appear in the Gulf of Georgia sites examined by Butler and Campbell (2004). The stability seen in the Glenrose Cannery assemblages fits with Lepofky

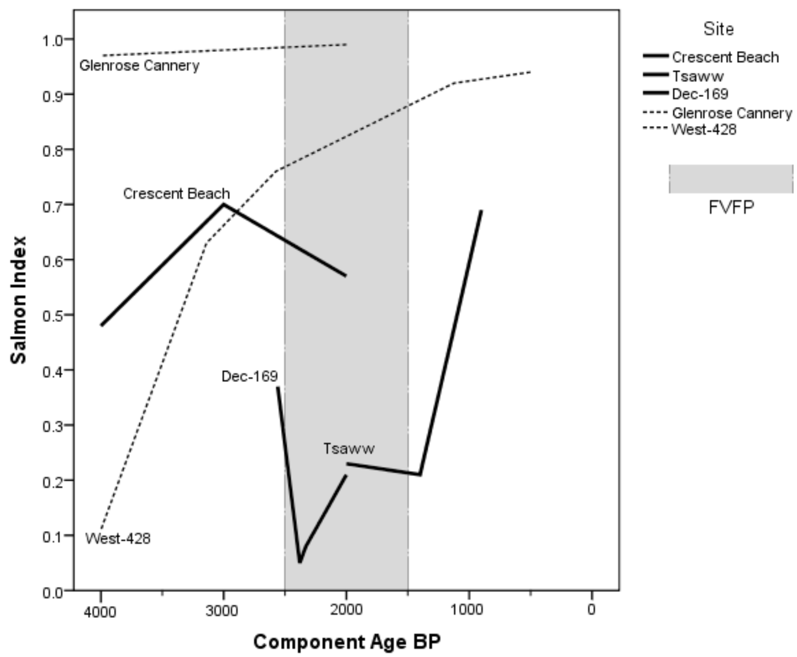


Figure 7.2. Salmon Index by Site Component (Salmonid NISP/Total Fish NISP, adapted from Butler and Campbell 2004).

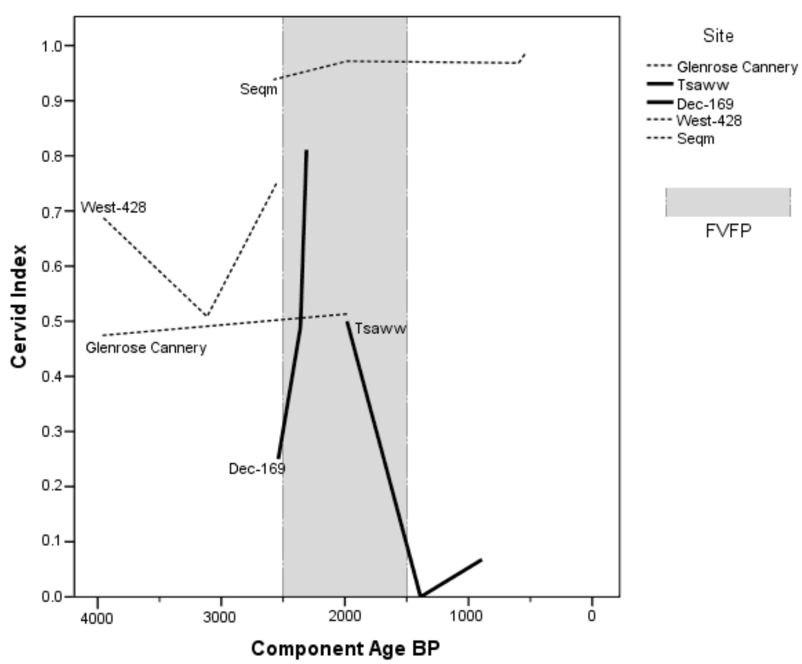


Figure 7.3. Cervid Index by Site Component (Cervid NISP/Total Mammal NISP, adapted from Butler and Campbell 2004).

and her coauthors' suggestion that the impact of the FVFP being mitigated on the Fraser. The West Point and Sequim sites have also been included for comparison; West Point indicates that the FVFP does not appear to impact Puget Sound. The Sequim mammal assemblage provides an inland site contrast that was also not impacted. While it is evident that additional inter-site faunal analysis is required to fully discern any changes in faunal assemblages caused by the FVFP, there appear to be trends indicative of the climactic disruption and increased resource heterogeneity in the region discussed by Lepofsky and her coauthors.

Changes in Harpoon Technologies

Changes are seen in harpoon technologies in general, both socketed and tanged, during the Marpole period. While not examined here, Northwest Coast archaeologists (e.g. Burley 1980, Mitchell 1990) have noted that composite socketed harpoons, a technology tied to the procurement of salmon in the ethnohistoric period (Suttles 1951:143), are rare during the Marpole period, although present in the preceding Locarno Beach period and common in the later Gulf of Georgia period.

A similar pattern is seen with retrievable points in this sample. The relative frequency of retrievable points to other types decreased during the Marpole period (Figure 6.39). The decrease in the relative frequency of retrievable points, coupled with their more robust construction and differing methods of line attachment, may indicate a shift in the tasks retrievable points were used for during Marpole. The shift towards robust bilateral line-attachment harpoons during the Marpole period (Table 6.29) may indicate a trend towards designing harpoons specialized for larger prey.

Although I suggest that specific technologies may have been adapted for more specialized tasks, based on this sample, it does not appear that regional specialization in barbed points for procuring certain types of resources occurred. Such specialization is one possible outcome of the increased resource heterogeneity and inter-group interactions Lepofsky and coauthors describe. Instead, the same functional classes are present throughout the Gulf of Georgia in the Marpole period (Figure 6.44, 6.45).

Straight fixed points form a substantial portion of the Marpole assemblages in examined. As discussed in Chapter 2, fixed points are most suited for the capture of fish in enclosed spaces, specifically riverine contexts (Kroeber and Barrett 1960). According to Berringer (1982:40), barbed spears could be utilized to capture salmon in traps and weirs, which would rectify issues of prey escaping one of the reasons behind retrievable points being preferred in open water.

I suggest that the use of composite socketed harpoons to procure salmon, at least in riverine contexts, may have decreased during the Marpole period. This decrease may have resulted from shifts in the timing of runs and the increased siltation of rivers and streams which would reduce the season for salmon harpooning activities. The FVFP may have led to individuals relying less on harpoons for the procurement of salmon, instead, as suggested previously, adapting tanged harpoon technologies for more specialized tasks.

Other existing technologies, and new innovations, may have been relied upon more for procuring salmon as a result of these environmental shifts. Technologies such as gaff hooks and leisters may have been more effective as Suttles' (1951:143) informants note that they were utilized in murky waters instead of harpoons. Fixed points are a flexible technology, which can be utilized in a wide variety of species in a wide range of contexts. Fixed points met a need for a flexible toolkit for marine and riverine resources. The use of sites such as traps and weirs for the procurement of salmonids (i.e. the use of natural and artificial contexts which would increase the utility of capturing salmonids with fixed points instead of harpoons) and reef-netting may have intensified as a result of the hypothesized decreased utility of harpoons for procuring salmon in rivers and streams during this period.

Overall, changes in barbed bone and antler point types during this time period indicate increased use of antler for robust non-socketed harpoons used for the acquisition of marine mammals, sturgeon, and possibly terrestrial mammals as well. At this time, the FVFP may be a strong contender for the environmental cause McMurdo (1972) hypothesized may have been responsible for the morphological changes seen in Marpole points. The reintroduction of socketed harpoons and a transition towards barbed point styles more similar to those of the Locarno Beach period towards the end of the Marpole period and the FVFP, may strengthen the plausibility of this climactic argument. Clearly additional work is needed in the areas of faunal analysis of Locarno Beach and Marpole assemblages, and seasonality studies to investigate whether or not there are are detectable changes in the timing of salmon runs.

VIII. CONCLUSIONS

The barbed bone and antler points of the Gulf of Georgia are complex technologies used for a wide variety of resource procurement activities that are tied to social systems of ranking and prestige. These systems (expressed as prestige bias), are not a detectable influence on the social learning of barbed point stylistic elements over the past 2,500 years. I propose that the shaft barbs of these points are the result of highly individualized learning (undirected guided variation) or communication with peers (horizontal transmission). Shaft barb attributes exhibit a high degree of morphological variation. I suggest that most of this variation is functionally equivalent. This variation may result from the use of barbs as personal identity markers.

The cultural-historical significance of attributes discussed by McMurdo (1972) was also assessed to determine if similar patterns existed in this sample. A clear transition from bilateral barb application and line attachment methods to unilateral barb application was detected around 3000 BP, the beginning of the Locarno Beach period. From 2500 to 1500 BP, the Marpole period, bilateral line attachment styles are re-introduced. During this period, the use of antler increased for all point types. Changes in the relative frequencies of functional classes through time were also detected. In general, fixed points were the most common barbed point type, followed by retrievable points, leisters, and unibarbed points. From 2500 to 1500 BP, the time period containing the largest sample overall of barbed points, included the highest absolute number of retrievable points. However, the relative proportion of retrievable points compared to other point types was less than in any other time period. The results of this analysis indicates that retrievable points dating to the Marpole period are morphologically distinct. However, they were not the most common class of barbed point in that period. The relative rarity and distinct morphology of Marpole retrievable points, I suggest, may be a result of climactic changes occurring in the Gulf of Georgia at that time (see Lepofsky et al. 2005).

Functional interpretations of barbed point attributes were also assessed. Metric attributes such as projectile width, length, and thickness vary by functional class. Head barbs, which serve as the arming element, also appear to demonstrate morphological variation according to functional class. Fixed points were examined for morphological variation that could be attributed to function as a fish spear or bird arrow, following Carlson's (1954) functional typology. It was apparent that base types and shaft barb frequency varied depending on point cross-section. This indicated that Carlson's typology was applicable to this sample and is useful in the classification of fixed points.

Areas for Future Research

This thesis did not examine sites along the Fraser River, or from the interior of British Columbia and Washington. Expanding the sample to re-analyze materials examined by McMurdo (1972) from the Fraser region would allow for a more thorough picture of barbed point variation throughout the region. It is possible that the modes and mechanisms of cultural transmission may vary in different geographic regions (e.g. Guglielmino et al. 2002; Eerkens et al. 2006). Similarly, examining barbed points from the interior in additional depth could provide new insights for functional interpretations.

Another potential line of research would be investigating whether or not conservative cultural transmission can be detected in the attributes of socketed harpoons from the Ozette site. The use of socketed harpoons by the Makah for whaling is well recorded in the ethnographic literature (e.g. Swan 1870; Curtis 1916; Waterman 1920; Goddard 1924; Gunther 1942; Singh 1966; Taylor 1974). Whaling has been long noted as a prestige activity among the Makah, and an examination of socketed harpoons from archaeological sites located in the northwest Olympic Peninsula may provide an excellent opportunity for detecting prestige bias in the archaeological record.

A c*haîne opératoire* analysis of both barbed points and socketed harpoons in the vein of David's (2003) analysis is also viewed as crucial in the further understanding of this technology on the northwest coast. A developed production sequence for barbed points would benefit future cultural transmission and functional studies. The question of whether barb attributes are the result of individualized experimentation and learning from peers, or are identity markers can be explored further experimental archaeology.

Experimental approaches may help construct stronger definitions for the subtypes of fixed points and will provide stronger evidence for functional classifications such as Carlson's (1954). An experimental approach may also answer another question posited by this thesis, whether or not Marpole period tanged harpoons are indicative of specialized use against large mammals (terrestrial or marine) and sturgeon as opposed to salmonids. Similarly, experimental archaeology can further examine the functional purpose of attributes such as barb density.

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Appendix A- Example Character State Analysis Form

Case # __________ Site __________
Unit __________ Level __________
Point Provenience __________ Artifact # __________

Typological Classification _____
Barb Paradigmatic Classification _____

Projectile Length _____
Maximum Projectile Width _____
Maximum Projectile Thickness _____
Minimum Number of Barbs _____
Minimum Number of Asymmetrical Barbs _____
Minimum Number of Microbarbs _____

Parallel Barb Groove: (0/1)

Curved Profile: (0/1)

Microbarb Type:
Notched (0/1)
Grooved (0/1)

Head Symmetry:
Bilateral (0/1)
Unilateral (0/1)

Head Length _____
Maximum Head Width _____

Maximum Head Barb Width _____

Head Barb Angle _____
<14.99 (0/1)
15-24.99 (0/1)
25-34.99 (0/1)
35-44.99 (0/1)
45+ (0/1)

Head Barb Silhouette:
Enclosed Barbs (0/1)
Extended Barbs (0/1)

Material:
Bone (0/1)
Antler (0/1)

Fire Modification:
Burned (0/1)
Calcined (0/1)

Shaft Symmetry:
Bilateral (0/1)
Unilateral (0/1)

Shaft Length _____
Maximum Shaft Width _____

Maximum Shaft Barb Width _____

Shaft Barb Angle _____
<14.99 (0/1)
15-24.99 (0/1)
25-34.99 (0/1)
35-44.99 (0/1)
45+ (0/1)

Shaft Barb Silhouette:
Enclosed Barbs (0/1)
Extended Barbs (0/1)

Head Barb Extension:
High (0/1)
Low (0/1)

Head Barb Shape:
Straight (0/1)
Squared (0/1)
Convex (0/1)

Ridged Head Barbs (0/1)

Head Microbarbs (0/1)

Degree of Head Barb Asymmetry:
None (0/1)
Low (0/1)
High (0/1)

Maximum Line Attachment Width _____
Line Attachment Length _____

Line Attachment:
Bilateral Line Guard (0/1)
Unilateral Line Guard (0/1)
Incised Line Guard (0/1)
Unilateral Notching (0/1)
Bilateral Notching (0/1)
Unilateral Shoulder (0/1)
Bilateral shoulder (0/1)
Spool (0/1)
Constriction (0/1)
Drilled Line Hole (0/1)
Gouged Line Hole (0/1)
Combination Line Hole (0/1)
Reverse Barb (0/1)

Shaft Barb Extension:
High (0/1)
Low (0/1)

Shaft Barb Shape:
Straight (0/1)
Squared (0/1)
Convex (0/1)

Ridged Shaft Barbs (0/1)

Shaft Barb Frequency:
Dense (0/1)
Isolated (0/1)

Shaft Microbarbs (0/1)

Degree of Shaft Barb Asymmetry:
None (0/1)
Low (0/1)
High (0/1)

Base Width _____
Base Length _____

Base Shape:
Conical (0/1)
Wedged (0/1)
Squared (0/1)
Rounded (0/1)
Flanged (0/1)

Asymmetrical Base (0/1)

Notes: (Missing Segments?)

Appendix B- Cladistics Analysis Cases as OTU

Case	Barb Shape	Ridged Barbs	Barb Silhouette	Mi1robarbs
3	0	1	0	1
4	0	1	1	1
5	0	1	0	1
6	0	1	1	1
9	0	0	0	1
10	0	1	1	1
12	0	0	1	1
13	0	1	1	1
15	0	0	1	1
17	0	0	1	1
18	0	0	0	1
22	0	0	0	1
25	0	1	0	0
26	0	0	1	1
33	0	1	1	1
34	1	1	0	1
37	0	1	0	0
41	0	1	1	0
44	1	1	1	1
46	0	0	1	0
47	1	1	0	1
51	0	0	1	1
52	1	1	0	1
53	1	1	0	1
56	0	1	0	1
58	0	1	1	1
59	0	0	0	1
61	1	1	0	1
63	1	1	0	1
64	1	1	1	1
68	1	1	1	1
69	0	0	1	1
71	0	1	0	1
75	0	0	0	1
76	0	0	0	1
80	1	1	0	1
82	1	1	0	1
85	0	0	0	1
88	0	0	1	1
89	0	1	1	1
90	0	0	1	1
91	1	1	0	1
94	0	0	0	1
95	1	1	0	1
208	0	1	1	1
209	1	0	0	1
211	0	0	1	1
213	0	0	1	1
214	1	1	0	1
215	0	0	0	1
216	1	1	0	1
218	0	0	1	1
221	0	1	1	1
222	0	1	1	1
223	0	1	1	1
224	0	1	1	1
225	1	1	0	0
226	1	1	1	1
227	0	0	1	1
228	0	0	1	1
231	0	0	1	1
233	0	1	1	1

Case	Barb Shape	Ridged Barbs	Barb Silhouette	Mi1robarbs
96	0	0	0	1
98	0	0	0	1
99	0	1	1	1
100	0	0	1	1
101	0	0	1	1
104	0	0	0	1
105	0	1	0	1
106	0	0	0	1
109	0	1	1	1
112	1	1	0	1
115	1	1	0	1
118	1	1	1	1
119	0	1	1	1
122	0	1	1	0
129	0	0	0	1
132	1	1	1	1
140	0	1	1	1
144	0	1	1	1
147	0	1	0	1
148	0	1	1	1
154	0	1	1	1
156	0	1	1	1
158	0	1	0	1
163	0	1	1	1
176	0	1	1	1
173	0	1	1	0
177	0	1	1	1
178	0	1	0	1
179	1	1	0	1
181	0	1	1	1
182	1	1	1	1
183	1	1	0	1
184	1	1	0	1
185	1	1	0	1
187	0	1	1	1
188	1	1	1	1
190	1	1	1	0
191	1	1	0	1
193	0	1	0	1
198	1	1	1	1
199	1	1	0	1
200	0	1	0	0
201	1	1	0	1
205	1	1	0	1
278	0	1	1	1
280	0	1	1	1
281	0	1	1	1
282	1	1	0	1
285	0	0	1	1
288	1	1	0	1
289	0	1	1	1
290	0	1	1	0
293	0	0	0	1
296	0	1	1	1
297	0	1	1	1
300	1	1	0	0
302	1	1	0	1
304	0	1	1	1
305	1	1	0	1
306	1	1	0	0
307	1	1	0	1
309	0	0	0	1

Appendix B- Cladistics Analysis Cases as OTU

Case	Barb Shape	Ridged Barbs	Barb Silhouette	Mi1robarbs
234	1	1	0	1
236	0	1	0	1
237	0	0	1	1
238	0	1	1	1
239	1	1	1	1
241	1	1	0	1
243	1	1	1	1
244	0	1	1	1
245	1	1	0	1
246	0	0	1	1
247	0	0	1	1
248	1	1	1	1
249	1	1	0	1
250	1	1	0	1
252	0	0	1	1
254	0	0	1	1
257	0	0	1	1
259	0	0	1	1
261	1	1	0	1
262	1	1	0	0
263	1	1	1	1
264	0	1	1	1
265	0	0	1	1
269	0	1	1	1
274	0	0	1	1
275	1	1	0	1
277	1	1	0	0
347	0	0	1	1
348	1	1	1	1
349	0	0	1	1
350	0	1	1	0
351	1	1	0	1
353	1	1	1	1
354	1	1	1	1
355	1	1	1	0
358	0	1	1	1
359	1	1	0	0
360	1	1	0	1
361	1	1	0	1
364	0	1	0	0
365	1	1	0	0
366	0	1	1	1
367	1	1	0	1
369	0	0	1	0
370	0	1	1	1
372	0	0	1	1
373	0	1	1	1
374	1	1	0	1
375	0	1	1	0
376	0	1	1	1
377	0	1	1	1
378	0	1	1	0
379	1	1	0	0
380	0	1	1	1
381	0	1	1	1
382	0	1	1	1
383	0	1	1	1
384	1	1	0	1
385	1	1	0	1
386	0	0	0	1
387	0	0	1	1
389	0	1	1	1

Case	Barb Shape	Ridged Barbs	Barb Silhouette	Mi1robarbs
310	0	0	0	1
312	0	0	0	1
313	1	1	0	1
314	1	1	0	1
316	0	0	0	1
317	1	1	0	1
318	0	0	0	1
320	0	1	1	1
321	0	1	0	0
322	1	1	0	1
325	1	1	0	1
326	0	0	1	1
329	1	1	0	1
330	1	1	1	0
331	0	1	1	1
332	0	1	1	1
333	0	0	1	1
335	0	0	1	1
336	0	0	1	1
337	1	1	0	1
338	0	0	1	1
340	1	1	0	1
341	0	0	1	1
342	0	0	1	1
344	0	1	1	1
345	1	1	0	1
346	0	1	1	1
401	0	0	0	1
402	1	1	0	1
403	0	1	0	1
404	0	1	0	1
406	1	1	0	1
407	0	0	1	1
409	0	1	0	1
410	1	1	1	1
411	0	0	0	1
412	0	1	1	1
413	0	1	1	1
415	1	1	1	1
418	0	0	0	1
419	1	1	0	1
421	1	1	0	1
422	0	0	0	1
423	1	1	0	1
425	0	1	1	0
428	0	1	1	1
430	0	1	1	1
435	0	0	0	1
436	0	1	1	1
437	0	0	0	1
438	0	1	1	1
439	1	1	0	0
443	0	1	1	1
444	0	0	1	1
446	0	0	1	1
447	0	0	1	1
449	0	0	0	1
450	0	0	0	1
451	0	0	1	1
452	0	1	0	1
454	0	0	1	1
455	0	0	0	1

Appendix B- Cladistics Analysis Cases as OTU

Case	Barb Shape	Ridged Barbs	Barb Silhouette	Mi1robarbs
390	1	1	0	1
391	1	1	0	1
392	0	0	1	1
394	0	0	1	1
395	0	1	0	1
396	1	1	0	1
397	1	1	0	0
398	1	1	0	1
399	0	1	1	1
400	1	1	0	1
469	0	0	1	1
472	0	0	0	1
473	0	1	1	1
474	0	1	0	1
476	0	0	0	1
477	0	0	1	1
478	0	0	1	1
479	0	0	0	1
480	0	0	0	1
482	1	1	0	1
483	1	1	0	1
489	0	0	1	1
491	0	1	1	1
493	0	1	1	1
495	0	0	0	1
496	0	0	1	1
497	0	0	1	1
500	0	1	0	0
501	0	0	1	1
503	0	0	0	1
504	0	0	1	1
505	0	1	0	1
508	0	1	1	1
509	0	1	0	1
510	0	0	1	0
512	0	0	1	1
513	0	0	0	1
514	0	1	0	1
*516	0	0	1	1
*519	0	0	0	1
*521	0	1	0	1
*523	1	1	0	1
*524	0	1	1	1
*526	0	1	0	0
*529	1	1	1	1
*530	0	0	1	1
*533	0	0	1	0
*534	0	1	1	1
*539	0	0	0	1
*540	1	1	0	1
*542	1	1	0	1
*544	0	1	0	1
*545	0	1	0	1
*547	1	1	0	1
*548	0	1	1	1

Case	Barb Shape	Ridged Barbs	Barb Silhouette	Mi1robarbs
456	0	0	0	1
457	0	0	0	1
458	0	1	1	1
462	0	0	0	1
463	1	1	1	1
464	0	0	0	1
465	0	1	1	1
466	0	0	1	1
467	0	0	1	1
468	0	0	0	1
*549	0	0	0	1
*552	0	0	1	1
*555	0	0	1	1
*558	0	0	0	1
*559	0	0	1	0
*560	0	0	1	1
561	0	0	1	0
*565	0	0	1	1
*566	0	0	0	1
*567	1	1	1	1
*568	1	1	0	1
*569	0	1	1	1
*571	0	0	1	0
*572	0	0	1	1
*573	0	0	1	1
576	0	0	0	1
*577	0	0	1	1
*579	0	1	0	1
*580	0	1	1	1
*582	1	1	0	1
*586	1	1	0	1
*589	1	1	0	0
592	0	1	1	1

*Outgroup Cases

Barb Shape- 0=Straight/Convex 1=Squared
Ridged Barbs- 0=Present 1=Absent
Barb Silhouette- 0=Enclosed 1=Extended
Microbarbs- 0=Present 1=Absent

Appendix B- Cladistics Analysis Classes as OTU

Class	Barb Shape	Ridged Barbs	Barb Silhouette	Microbarbs
*AGAG	0	0	1	0
*+AGAC	0	0	1	1
*AGTG	0	0	0	0
*AGTC	0	0	0	1
ACAG	0	1	1	0
*+ACAC	0	1	1	1
*ACTG	0	1	0	0
+ACTC	0	1	0	1
TGTC	1	0	0	1
TCAG	1	1	1	0
*+TCAC	1	1	1	1
*TCTG	1	1	0	0
*+TCTC	1	1	0	1

*Outgroup Classes (Classes Present at EaSu5, ElSx1, FaSu2, FaSu10)
+Alternative Outgroup Classes (Classes Present in 3500+ BP Time Period)

Barb Shape- 0=Straight/Convex 1=Squared
Ridged Barbs- 0=Present 1=Absent
Barb Silhouette- 0=Enclosed 1=Extended
Microbarbs- 0=Present 1=Absent

Appendix B- Cladistics Analysis Sites as OTU

Site	AGAG	AGAC	AGTG	AGTC	ACAG	ACAC	ACTG	ACTC	TGTC	TCAG	TCAC	TCTG	TCTC
45IS31	0	0	0	0	0	1	0	1	0	0	0	0	0
45IS31b	0	0	0	0	0	1	0	1	0	0	0	0	0
45IS7	0	0	0	1	0	1	0	1	0	0	0	0	0
45SJ1	0	1	0	1	0	1	1	0	0	1	1	0	1
45SJ105A	0	0	0	0	0	0	0	0	0	0	0	0	0
45SJ185	0	0	0	0	1	1	0	0	0	0	0	0	0
45SJ24	1	0	0	0	0	0	0	0	0	0	1	0	0
45SJ24 Kennedey	0	1	0	1	0	1	0	1	0	0	1	0	1
45SJ24 Op A	0	1	1	1	0	0	0	1	0	0	1	0	1
45SJ24 Op D	0	1	0	1	0	0	0	0	0	0	0	0	0
45SJ25	0	0	0	0	0	1	0	0	0	0	0	0	0
45SJ280	0	1	0	1	0	1	0	1	0	0	0	0	1
45SK37	0	0	0	0	0	1	1	0	0	0	0	0	0
45SK59a	0	1	0	1	1	1	0	1	0	0	1	0	1
45SK7	0	0	0	0	0	0	0	0	0	0	1	0	0
45WH1	0	1	0	0	1	1	1	1	0	0	0	0	0
45WH11	0	0	0	0	0	1	0	1	0	0	1	0	0
45WH17	0	0	0	0	0	1	0	0	0	1	1	0	1
45WH172	0	0	0	0	0	1	0	0	0	0	0	0	0
45WH29	0	0	0	0	0	0	0	1	0	0	0	0	0
45WH34	0	0	0	0	0	0	0	0	0	0	1	0	1
45WH9	0	0	0	0	0	0	1	0	0	0	0	0	1
DcRt10	0	0	0	0	0	1	0	0	0	0	1	0	1
DcRt13	0	0	0	0	0	0	0	0	1	0	0	0	0
DcRt15	0	1	1	1	1	1	0	1	0	1	1	1	1
DcRt16	0	1	1	0	0	1	0	1	0	0	1	1	1
DcRt9	0	0	0	1	1	1	0	0	0	0	0	0	1
DcRty	0	0	0	0	0	1	0	0	0	0	0	0	0
DcRu12	0	1	0	1	1	1	1	0	0	1	0	1	1
DcRu2	0	1	0	0	1	0	0	0	0	0	1	0	1
DcRu4	0	0	0	0	0	0	0	0	0	0	1	0	0
DcRu7	0	0	0	0	0	1	0	0	0	1	0	0	0
DcRu78	0	0	0	0	0	1	0	0	0	0	0	1	1
DcRv1	1	1	0	0	1	1	1	0	0	0	0	1	1
DcRvy	0	0	0	0	0	0	0	0	0	0	0	1	0
DcRwy	0	0	0	0	0	1	0	0	0	0	0	0	0
DdRt6	0	0	0	0	1	0	0	0	0	0	0	1	0
DdRu1	0	0	0	0	0	1	0	0	0	0	0	0	0
DdRu12	0	0	0	0	0	1	0	0	0	0	0	0	0
DdRu4	0	1	0	1	0	1	0	1	0	0	0	1	1
DdRu8	0	0	0	0	0	0	0	1	0	0	0	0	0
DdRuy	0	0	0	1	0	0	0	0	0	0	1	0	0
DdRvy	0	0	0	0	0	1	0	0	0	0	0	0	0
DeRt1	0	0	0	0	0	0	0	0	0	0	1	0	0
DeRt2	0	0	0	1	0	0	0	0	0	0	0	0	1
DeRty	0	0	0	0	1	0	0	0	0	0	0	0	0
DeRu1	0	0	0	1	0	1	0	0	0	0	1	0	0
DeRu15	0	0	0	1	0	1	0	0	0	0	0	0	0
DeRv107	0	0	0	1	0	0	0	0	0	0	0	0	0
DgRw4	0	1	1	1	0	1	1	1	0	0	1	0	1
DhRx16	0	1	0	0	0	0	0	1	0	0	0	0	0
DhRx6	1	1	0	1	0	1	0	1	0	0	0	0	0
*EaSu5	0	1	0	0	0	0	0	0	0	0	0	0	0
*ElSx1	1	1	1	1	0	1	1	1	0	1	1	0	1
*FaSu10	0	0	0	0	0	1	0	0	0	0	0	0	0
*FaSu2	0	0	0	0	0	0	0	0	0	0	0	1	1
Thompson Survey 3A17	0	0	0	0	0	1	1	0	0	0	1	0	0

*Outgroup Sites 0=Absent
1=Present

Appendix C- Comparison of Metric Data with Previously Published Measurements

Case #	Site	Artifact #	Length (mm)	Length* (mm)	Width (mm)	Width* (mm)	Thickness (mm)	Thickness* (mm)	Source
183	45WH17	730	127.9	128	9.4	9	4.8	5	Grabert, et al. 1978
186	45WH17	1170	77.7	76	37.45	37	10.1	10	" "
206	DcRt10	658, 659	112.29	113	27.96	28	13.46	12	Kenny 1974
209	DcRt13	234	135.17	136	24.57	26	12.85	13	Mitchell 1979
220	DcRt15	245	108.45	110					McMurdo 1972
224	DcRt15	292	99.36	99					" "
226	DcRt15	294	75.86	75					" "
227	DcRt15	340	71.79	72					" "
228	DcRt15	341	74.6	75					" "
231	DcRt15	384	121.52	123					" "
233	DcRt15	386	84.81	86					" "
236	DcRt15	479	85.5	85					" "
244	DcRt15	982	103.19	105					" "
245	DcRt15	1044	73.79	75					" "
254	DcRt15	1245	67.55	67					" "
257	DcRt15	1365	96.59	97					" "
261	DcRt15	1484	102.97	103					" "
358	DcRu78	28	149.03	150	10.79	10.8	4.14	4.5	Mitchell 1981
359	DcRu78	47	108.24	108	10.85	10.9	5.73	5.8	" "
360	DcRu78	58	43.85	45	10.31	10.1	7.35	7.3	" "
370	DcRv1	2183	113.78	115					McMurdo 1972
376	DcRv1	152	81.22	83					" "
378	DdRt6	42	71.21	71	9.07	9	6.23	6	IR Wilson Consultants 2005
379	DdRt6	43	168.09	169	10.74	10	5.8	6	" "
453	DgRw4	1189	64.7	65	6.23	4	3.69	3	Burley 1989
454	DgRw4	1196	84.59	85	8.25	9	9.58	5	" "
456	DgRw4	1212	104.87	105	9.58	10	4.33	5	" "
458	DgRw4	1225	115.4	116	11.82	13	6.37	6	" "
460	DgRw4	1404	37.07	36	15.69	15	10.69	10	" "
463	DgRw4	1462	57.92	59	10.97	11	5.69	6	" "

Appendix C- Comparison of Metric Data with Previously Published Measurements

Case #	Site	Artifact #	Length (mm)	Length* (mm)	Width (mm)	Width* (mm)	Thickness (mm)	Thickness* (mm)	Source
465	DgRw4	1523	130.52	129	28.52	29	9.49	11	" "
468	DgRw4	1597	83.78	83	17.59	18	8.3	8	" "
473	DgRw4	1907	178.93	176	33.21	33	12.41	13	" "
477	DgRw4	1963	127.65	128	10.1	10	5.89	6	" "
479	DgRw4	1973	171.38	172	8.89	9	6.71	7	" "
485	DgRw4	2159	86.46	87	24.17	25	8.54	9	" "
487	DgRw4	2195	53.33	53	10.17	10	4.45	5	" "
490	DgRw4	2249	62.18	63	11.71	12	5.55	6	" "
493	DgRw4	2422	153.12	155	13.68	14	7.78	8	" "
504	DgRw4	2867, 2873	126.96	127	8.46	8	6.14	6	" "
552	ElSx1	fs.10.0.6	82.72	83					McMurdo 1972
559	ElSx1	fs.10.11.97	78.4	78					" "
562	ElSx1	fs.10.10.24	90.1	89					" "
568	ElSx1	fs.4.0.14	122.2	122					" "
569	ElSx1	fs.4.0.27	68	68					" "
571	ElSx1	fs.5.4.3	105.4	105					" "

*Length, width, and thickness measures converted to millimeters from respective sources
Measurements presented for DdRt6 #42 are inconsistent with IR Wilson Consultants 2005 Artifact Plate 9 and measures from this analysis
McMurdo's analysis of DgRw4 False Narrows has been omitted due to its being comparable with Burley's measures and excluding projectile thickness